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THE UNIT OF VALUE IN ALL TRADE.

By Edward Atkinson.

MODERN trade and commerce consist in an exchange of services or of products for mutual gain or benefit. Very few men now consume any great part of their own product. Division of labor exists because a more abundant supply of goods can be made when each nation, each section, each State, each community, and finally each man or woman, works upon a special product to which climate, soil, conditions, and special personal skill or aptitude are most fully adapted. Each then produces more goods of one kind than each can consume. This makes *supply*. Each then wants some part of the product of many neighbors. That makes *demand*.

All men are neighbors; all States and nations are interdependent. The science of the engineer has converted distance into a mere fraction of a cent a ton per mile. The day's work of a mechanic upon the seaboard covers the cost of moving his year's supply of bread and meat a thousand miles. The western farm a thousand miles or more away is next door to the eastern workshop, and it often costs an eastern workman more to move a barrel of flour to his house from the railway station to which it has been brought than it did to get it to the station from the far-away western farm. This year eleven to twelve tons of food, fuel, fiber, or fabric will be moved 112 miles over the railways of this country for every man, woman, and child in it. The cost of this service to each one will be $10 or a little more. Each year for many years the quantity has increased greatly, and the distance but little, while the price of the service has diminished. If a pair of horses in steady work for 300 days in a year could move two tons six-

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teen miles a day, then it would take seven pairs of horses for each fifty persons to do the work of the railways at twelve tons 112 miles each. That would require the work of over 18,000,000 horses to provide the people of this country with the food, fuel, fibers, and fabrics now moved for them by the railways of the United States at a charge of $10 each, or a fraction more.

The distance is measured in miles—the price of the service is measured in dollars.

What is a dollar?

It is a coin made either of gold or of silver. A coin is a piece of silver or gold made in the shape of a flat disk and stamped by the government in order to certify its weight and quality.

The silver dollar weighs 412½ grains,—nine-tenths pure silver, one-tenth alloy.

The gold dollar weighs $25\frac{8}{10}$ grains,—nine-tenths pure gold, one-tenth alloy.

The grain is the common unit of weight; which dollar is the unit of value? The answer is in the law of the land.

The statutes of the United States provide that the gold dollar is the unit of value. There can be but one *unit.*

The unit of weight is the attractive force exerted between a unit of mass and some given body at a fixed distance. One cannot give so absolute a definition to a unit of value because the valuation or estimation in which men hold any given substance or product of human labor, whether gold, silver, copper, wheat, corn, or cotton, varies with the relative supply and demand.

The demand of the world for gold is constant; it will buy anything anywhere; it varies very slowly from generation to generation; the demand for silver is less in ratio to supply; the demand for copper is constant, but the supply increases in greater measure; the valuation of wheat, corn, and cotton varies with each season, in each country. The exchange of products is commerce.

Yet, without a unit or standard of value, by a comparison with which the exchange of products is expressed in terms of price, trade and commerce would be impossible except by barter.

There must be a unit of value or denominator which is the standard in all transactions. In order to comprehend the simple elements in this case one must separate the idea of money which circulates without any act of legal tender, from money of which the acceptance is forced by an act of legal tender.

The international commerce of the world consists of sales and

purchases made by individuals in each country. When a sale of goods is made, the vendor buys the money. When a purchase is made, the vendee sells money. The specific kind of money in each State, country, or nation may be legal-tender paper money or promises to pay, legal-tender silver money or legal-tender gold money. But when the remittance is to be made from one country to another, each kind of money must be converted into that kind which passes current the world over without any act of legal tender.

There is but one kind of money which meets this condition, and that is money made of gold, or gold itself. It follows that, without acts of legal tender or in spite of them, without legislation or in spite of it, without international agreement, but by a process of natural selection, a given weight of gold has become the standard or unit of value in the world's commerce.

It matters not whether the gold is made into coin or not; coins are estimated or valued or may be exchanged one for another only at the ratio of pure gold in each one. Certified gold bars or ingots serve the same purpose in making international remittances and are often preferred.

The higher law of commerce, laid deep in human nature, has established gold and gold only as the unit or standard of value. This fact must be recognized in all monetary legislation in every State or nation that takes part in international commerce, and its own unit of value must be adjusted to this fact and to this condition. "It is a condition and not a theory."

The welfare and prosperity of this country depend in great measure upon the recognition of this fact and of this condition, because we produce more food than we can consume, more fibers than we can spin, more oil than we can burn, and we are tending to produce more iron than we can use. Under our favorable conditions of soil, climate, and government, our light national taxation, and our freedom from standing armies and the onerous conditions of passive war which oppress all other machine-using nations, we make these necessary products in the greatest abundance, at the lowest measure or cost of labor in terms of days or effort, and at the lowest cost per unit of product in terms of money; it follows that the working people of this country secure the highest wages, such high rates being the result of the low cost of production.

The product is greater in proportion to the number of persons employed than anywhere else; a less proportion of the product is diverted to taxation; the increase of capital is more rapid; the

capital is more effective ; the workmen are more free from the interference of government ; finally, each workman is also free to use his own time and his own capacity without restriction except such as each one may choose to impose upon himself. In other words the working people of this country, whether engaged in mental, mechanical, or manual work, secure to their own use and enjoyment a larger portion of a larger product than those of any other country. But this product must be bought, sold, and exchanged before its benefits can be enjoyed by those who share in the work. Now, since the price or conversion into money of this our whole product, especially of our farms, depends substantially upon what the excess which we cannot consume will bring for export, all our prices must be adjusted to the world's standard or unit of value,—which is a given weight of pure gold.

Fifteen to twenty per cent. of the product of our farms is exported, varying year by year with the supply and demand.

Under these conditions it is necessary for us to maintain our present unit of value, the dollar made of gold, because all our exports are valued at the standard of gold: especially because our largest customer is Great Britain, where the standard or unit of value is the pound sterling. In 1892 our total exports were valued at a little over $1,000,000,000, of which Great Britain bought in value over $500,000,000.

The unit of value of the United States is a dollar, weighing $25\frac{8}{10}$ grains nine-tenths fine. The quantity of pure gold in it is 23.21997 grains.

The unit of value of Great Britain is a pound sterling.

The coin which corresponds to a pound sterling, when of full weight, is named a "sovereign," weighing 123.270 grains,—eleven-twelfths fine and containing 113.0016 grains of pure gold.

The unit of value of the United States is therefore 23.21997 grains of pure gold. The unit of value of Great Britain is therefore 113.0016 grains of pure gold. The ratio of one dollar to one sovereign is 1 to 4.866. The ratio of each grain of gold in either is 1 to 1.

This valuation or estimation cannot be changed by statute, treaty, or agreement.

The effort of the advocates of a bimetallic treaty of legal tender and of the advocates of the free coinage of silver dollars of full legal tender is to alter these facts and conditions by legislation. An act of legal tender works by force. Under an act of legal tender

the effort is made to force a seller of goods to accept a kind of money which may or may not contain the elements of its own value in its own substance. Gold is worth as much—that is to say, is valued as highly—after it is melted as it is in the coin. Silver dollars will not buy as much in the world's markets after they are melted as they purport to be worth in the coin. They circulate in our own country at a parity only because they can be converted into gold at their nominal and not at their true ratio.

The ratio of weight is one grain of gold in a gold dollar to sixteen grains of silver in a silver dollar, but the gold in a gold dollar will now buy nearly twice as many grains of silver in bullion as are to be found in the silver dollar.

Which shall be our permanent unit of value? There can be but one; the very name is single. It is not possible to think of two units or of duality in a unit.

Lincoln said that this country could not exist, one half slave, the other half free. The civil war justified his reasoning and his acts. The nation was established on the unit of liberty.

Neither can the money of a country exist, one half good at the unit or standard of the world's value, the other half bad. There can be but a single unit of value; it is now established, and it will be maintained. The silver craze is a rebellion against common law and common sense; this rebellion is now being suppressed.

It is manifest, however, that no nation could supply itself with a sufficient number of actual units of value or actual coins made of gold to serve in each and every bargain and sale, or to measure each exchange by an actual delivery of coin. Such conditions only exist in barbarous countries, where men cannot trust each other.

The bill of exchange, the check, the bank-note, and the government note now take the place of the actual coin; but, in order that their credit may be sustained, these titles to money or to units of value must be redeemed or paid in the units of value made of gold, or else no man can trust them.

Neither is it expedient to make use of coin or standard units of value to any great extent in actual service. The place for coin is in the reserves of banks and bankers, not often needed but always ready at the time of need. When the gold is in the bank reserve as a basis of credit, its force may be compared to the locomotive engine; when it passes from hand to hand, it only does the work of a wheelbarrow. When gold is held in reserve, it serves as a

basis of manifold credits, but when in actual circulation each dollar passed from hand to hand serves for only one transaction.

These transactions consist in making exchanges of cotton for corn, food for iron, cloth for shelter, etc. The man who sells cotton buys a title to coin ; he receives a bank-note, a check, or a bill of exchange, which gives him a title to coin or money held in reserve by the bank or banker.

He seldom wants the coin, almost never if he can trust the bank-note and feel sure that he may get the coin if he needs it. The coin in the bank is the unit of value or standard of redemption. It must be single, it must be just, it must be at the standard or unit of value of the world because the price which the man gets for his cotton or his corn or his iron, or whatever he sells, is fixed and determined by that standard.

Again, the man who has sold cotton, grain, or provisions and who has received a check, draft, bank-note, bill of exchange, or United States note in return for the same,—all of which are titles to dollars or other units of value at the gold standard,—may deposit such title to money in a bank.

This title to money or units of value is placed at his credit and becomes a bank deposit. It is right and just that when he spends that money,—that is, when he has occasion to draw upon the bank in order to pay for farm machinery, tools, clothing, sugar, tea, coffee, or any other article domestic or foreign that he wants,—he shall be paid in dollars or units of value of the same kind or quality that he had put into the bank,—namely, gold dollars or their equivalent.

His purchases and sales are all made in terms of dollars ; a dollar is a coin ; the gold dollar is the unit of value ; the gold in the dollar will buy anything anywhere ; the gold in it measured by weight in grains is the unit of value in the world's commerce.

The silver dollar is not a unit of value ; the silver in it will not buy as much—perhaps not half as much—as the gold in the gold dollar. If the United States government did not receive it for taxes or redeem it in gold, it would be worth 50 to 70 cents, varying day by day. Can trade be safely conducted by such a standard ?

If the pound, the yard, or the gallon varied day by day or month by month, could any one safely agree to buy or sell by these standards? Of course not. How then can it be safe to conduct commerce except under contracts in units of value of the same

standard, and that a standard which varies only in long periods hardly perceptible in any one generation?

If these facts and conditions are admitted, then commerce consists in the exchange of product for product at a single standard or unit of value.

The unit of value of this country is the number of grains of gold in a dollar,—namely, 23.21997 grains.

The unit of value in Great Britain is the number of grains of gold in a pound sterling,—namely, 113.0016 grains.

The unit of value in Germany is the number of grains of gold in a mark,—namely, 5.53134 grains.

The unit of value of France is the number of grains of gold in a franc,—namely, 4.48035 grains, and so on throughout the world.

In all countries, whatever the lawful money or legal tender money may be, all kinds are brought to the same unit of value, the grain of pure gold in international commerce. Gold is the monetary unit of value—not by statute, treaty, or agreement, but in fact; because it is the safest, surest, and only just standard or unit that the world has yet discovered.

If the Brussels conference could bring about an international agreement to establish a certain convenient weight of gold to be converted into a new coin nearly corresponding to the $5 gold coin of this country, a great gain would ensue.

The $5 gold coin, 20 quarters, of the United States contains grains of gold	116.09985
The English sovereign, 20 shillings	113.0016
The German 20-mark piece	110.6268
The French 25 francs	112.0087
The Spanish 25 pesetas	112.006

So near are the great commercial nations of the world to a uniform standard or unit of value by weight of gold. Could it once be established, its name might well be the Token of Peace.

In commerce each man, each State, each nation serves the other, and the whole fabric rests upon mutual service. All nations are interdependent. The unit of value is established. Commerce overcomes all obstructions, natural or artificial, but the more free from obstruction the greater the mutual service. The establishment of a common coin containing the same weight of gold, known by one name—of the same value everywhere—would remove many difficulties that now obstruct trade.

If such a vision could be realized, certain great centers of trade would become the clearing-houses of the world, interchanging their certificates with each other, each keeping its own reserve of

the units of value in gold coin or in gold bars, and thus often avoiding the risk and the cost of moving great quantities of gold forward and back across the ocean, creating an alarm due only to the imagination.

Prices would then vary only according to the supply of and demand for the goods, wares, and merchandise which are the subjects of commerce; and all uncertainty about the quality of the money, or about the standard or unit of value, would be ended.

Having thus assured the great central deposits of the world's money of redemption at central points available for transfer by national clearing-house certificates, the lesser deposits in proportion to our own requirements would be in the bank reserves or clearing-house centers of our own country; also subject to transfer by the issue of clearing-house certificates representative of coin or units of value.

It will be observed that the great volume of exchanges is conducted by the issue of bills of exchange or drafts, sometimes on demand, often drawn payable at a future date. These drafts or notes promising deferred payment are the representative or symbol of the products passing from the producer to the consumer. These instruments of exchange or titles to money are the subjects of discount and are dealt in by banks and bankers. It will also be observed that a very small part of the traffic of the country is conducted by the use of bank notes, government notes, or coin. Very little gold coin is ever seen in circulation; its true place is in the bank reserves as a basis of credit.

At times there is a pressure upon the reserve. When this occurs within or among the banks themselves, relief has been found in the issue of Clearing-House Certificates. What occurs is this: while some banks have large reserves of lawful money, more than they need to sustain their own daily obligations, others have ample resources falling due at a later date but not at once available. Then the banks combine; each bank needing aid to meet its daily obligations places in the hands of a committee its securities of undoubted character available or payable at a future date; upon these securities the clearing-house certificates are issued at the ratio of seventy-five per cent. of the value of the securities pledged by each bank under the guarantee of all the combined banks in the association. [For forms see page 698.]

These certificates pass as money in the settlement of bank balances; they are held to the standard of redemption in lawful

money ; the gold itself is not wanted in any of these transactions ; what is required is an instrument of credit tied to the standard of redemption in gold and backed by the reserves of all the banks combined in that association.

If the draft on reserves becomes general and a semi-panic ensues, the emergency is met by the combined banks each supporting the other. If it goes so far as to reduce or imperil the joint reserve, then the credit extended by the banks to the community is cut down, trade suffers, buyers and sellers are kept apart merely because the mechanism of exchange is disordered, as it is now. At the present time the country is full of the elements of wealth and welfare ; real capital is abundant ; labor has been fully employed at the highest rates of wages. The world needs all that we have to spare. Only the mechanism of exchange is disturbed by distrust.

May there not be found in this invention of clearing-house certificates a solution of the problem of the currency? A certain amount or quantity of small notes, bank bills, and the like is required, but this quantity varies at different times and seasons. The coin or lawful money cannot be drawn from bank reserves without restricting the basis of credit at the time when credit is most needed. What is needed are instruments of credit in small sums that may pass from hand to hand as the transactions become greater or less. Gold is not needed and is not as suitable as a note, but the redemption of the note must be absolutely assured. The national bank notes are secured by the deposit of United States bonds. The tax on State bank-notes is maintained, not for the purpose of collecting a revenue, but for the purpose of preventing the issue of such notes. A fear exists lest the redemption or payment of the note on demand may not be assured. Bad banking imperils the note as well as the deposit.

There are many other securities which would be as safe in support of bank notes as the bonds of the nation. How and by whom are they to be selected and held?

It should be observed that the losses by bad debts on the wholesale traffic of this country in any decade are less than one-half of one per cent. a year. No well-managed bank would pay the strongest guaranty company one per cent. upon the obligations discounted by it to assure payment at maturity. At all times and under all conditions the obligations held by well-managed banks are sure to be ultimately paid to the amount of over 99 per cent.

of the total obligation. It is an evidence of bad banking if they are not, and bad banking is sure to be detected by the managers of a clearing-house.

It is from the best of these obligations at 75 per cent. of their value that the securities are selected by clearing-house committees when clearing-house certificates are issued upon their pledge. They are representative of property of the safest kind or of products of various kinds on the way from producer to consumer, valued at the world's unit of value,—gold coin.

It needs but one step more in the development of this invention and we should be served with the safest type of currency,—clearing-house certificates bearing no interest to be issued in sums of $5 and $10 to the order of each bank that could use them for general circulation, redeemable on demand by such bank, or in default redeemable in coin at the clearing-house, which would reimburse itself from the securities deposited with it.

An annual charge of one per cent. per annum by the clearing-house would more than compensate for losses and expenses.

If it is necessary or expedient to maintain national supervision, it may be justified because these certificates would circulate as money. That supervision would not be diffused as it now is over more than three thousand banks, but would be limited to the several clearing-house associations, where the strictest care could be maintained over the quality of the securities pledged by each bank for the redemption on demand of the certificates issued to it. A very small tax payable to the government would suffice for the payment of the most competent supervisors.

No one could be forced to take these instruments of exchange, they would not be a legal tender; but who would refuse them?

The ebb and flow of these certificates would correspond to and would be the representative of the volume of traffic. When money is called for to move the crops, these certificates would serve as the medium; they would be symbols of the crops, and the consumption of the crops would furnish the means of redemption. Behind them would be the central reserves of gold coin, next the securities representing property or produce at gold value, next the capital of each bank to which they were issued, finally the combined capital of all the banks in the clearing-house association from which each class of certificates emanated.

If such a currency would not be safe, no currency except one based dollar for dollar upon gold coin would be safe.

Commercial paper well chosen, representative of products on the way from producer to consumer, is a safer basis of security for small notes than the bonds or evidences of debt of nation, State, city, or town; because such obligations are representative of the active capital of the whole community of which the use or consumption will furnish the means of redemption.

When the standard or unit of value is assured and redemption is certain in gold or its equivalent, the gold itself may rest in ample reserves to be drawn upon only in settlement of balances.

If the credit of the unit of value is endangered by the threat of forcing the people under acts of legal tender to accept coin made of silver which is worth less as bullion than it purports to be worth in the coin, no device for supplying notes or any other form of currency will suffice, and no safe system of banks or banking can be maintained.

Credit will be refused to the individual citizens of a country which supports such measures, because by their very support of them they declare themselves not fit to be trusted.

There is a unit of value. It exists without regard to legislation, treaty, or agreement. It is gold. To that standard of value the monetary system of every commercial State must be adjusted. A given weight of gold is the standard of value everywhere; with it all products can be purchased and all debts can be discharged. No other substance or product of human effort meets these necessary conditions.

Although a given weight of gold is *de facto* the unit of value of the commercial world, it by no means follows that silver will cease to be used for subsidiary purposes. Bi-metallism exists *de facto*. Tri-metallism exists. Quadru-metallism exists. Gold, silver, nickel, and copper are made use of for conversion into coin, and these coins are used for monetary purposes.

What is in fact proposed under the technical name of "bi-metallism" is to undertake to maintain silver coins of given weight at a parity or equal to gold coins of given weight under a system of bi-legal-tenderism; an awkward combination of words, but one which is necessary to express the true purpose.

The origin of acts of legal tender among English-speaking people was the decree of an English king making it a penal offence to refuse the king's money after he had debased the coin of the realm.

No act of legal tender is required to enforce the acceptance of

good money. The only true definition of good money is "a coin which is worth as much after it is melted as it purports to be worth in the coin."

A gold dollar or its multiple in coin meets this condition; it is good money. A silver dollar does not meet this condition; it is bad money.

Under this pretext of free coinage the attempt is made to force bad money into circulation by an act of legal tender.

What is sought is a treaty under which either gold coin or silver coin at certain proportionate weights may be forced upon creditors by debtors under acts of international legal tender. The prospect of such an agreement is very remote. Without it silver will continue to be used for monetary purposes in the form of coin, perhaps by many poor nations as almost the only coin or medium of exchange; by others for subsidiary purposes. Under these conditions gold will maintain its position as the unit of value in the world's commerce, and only those nations will hold a position either paramount or equal in their terms of competition with others that maintain the gold unit of value both for their external and their internal trade and commerce.

It is told in one of the old nursery tales that the pig on the way to market would not get over the stile, the dog would not bite the pig, the stick would not beat the dog, the fire would not burn the stick, and so on; the whole procession was stopped by the pig. The pig that won't move now is pig silver piled in the Treasury vaults. Move it out of the way. The law is plain. If the act compelling the Secretary to buy pig silver is construed strictly in all its parts, it is as much his duty to sell pig silver as it is to buy it. He must sell the excess when the amount in the Treasury exceeds the amount of notes outstanding which were issued for its purchase. The law provides that "no greater or less amount of such notes shall be outstanding at any time than the cost of the silver bullion *then* held in the Treasury purchased by such notes."

Of late the people have refused to keep the notes outstanding, —they are being presented for redemption faster than they are issued. The amount of pig silver at cost now in the Treasury is greater than the amount of the notes outstanding. That condition is contrary to law. What other course is open to the Secretary of the Treasury than to move this pig silver to market by selling the excess so as to keep the amount of bullion in the Treasury at cost "no more and no less than the amount of notes outstanding?"

THE LEADVILLE OF TO-DAY.

By A. F. Wuensch.

LEADVILLE, with its great bonanza mines, and its phenomenal record of a metal production in fifteen years of nearly two hundred million dollars, presents an ever interesting and fascinating subject. The story of one of nature's most prodigal gifts of mineral wealth, of rapid and great industrial achievements, and the commercial and social results accompanying the development of a great mining camp, can never become stale or tiresome. Leadville is near the center of Colorado, and, since the development of its mineral wealth, it has been practically the heart and life of the State. The opening of the district in 1878 gave a new impetus to mining in the Rocky mountains generally, and the initial product of Leadville mines built the first fine business blocks of Denver and other western towns, and supplied funds for the first miles of railway of some of the most important lines of the present day in the west.

Owing to its high location—10,200 feet above sea-level—the place is frequently referred to as the "City of the Clouds." It is two miles above coast cities, where the clouds are supposed to hold supreme sway; still there is hardly a place on earth that can boast of clearer and brighter skies, or a quieter and more agreeable atmosphere. To be set down unexpectedly in Leadville, one would not appreciate the altitude unless he were an experienced mountaineer who, perceiving the absence of forests on the mountain sides a few thousand feet above the plane of the town, would readily estimate the elevation.

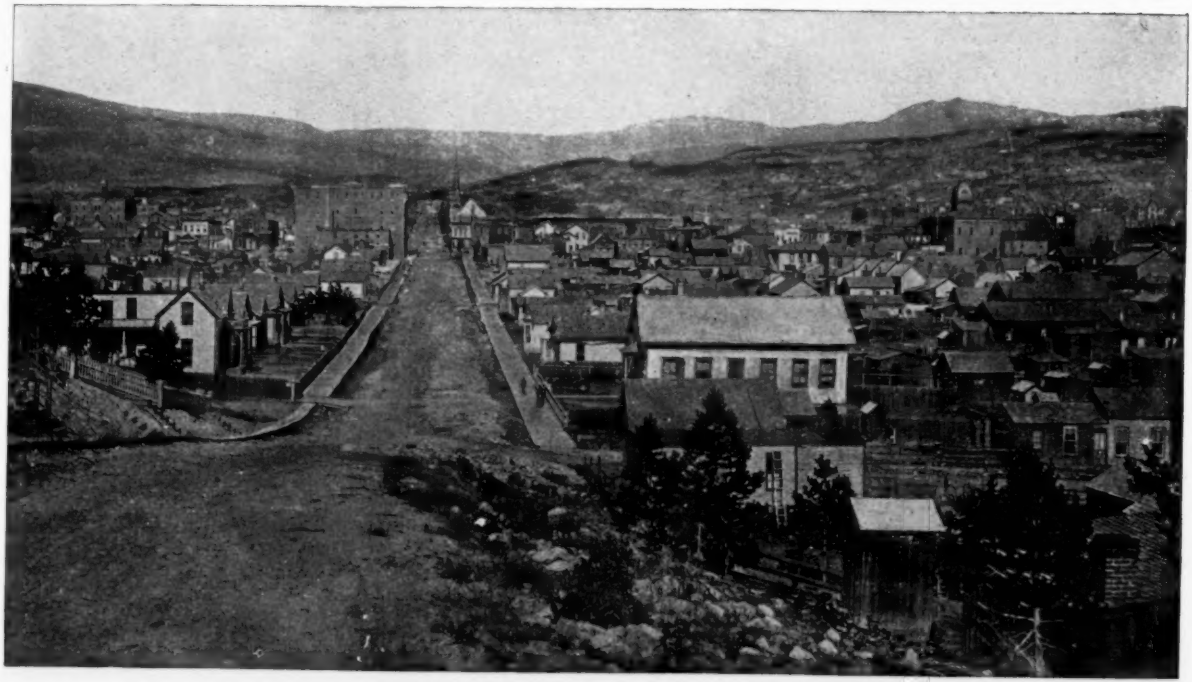
Leadville is situated on the eastern edge of a valley three to seven miles wide and twenty-five miles long. To the westward, ten miles distant, is the continental divide, composed of Homestake, Massive, Elbert, and Harvard peaks, some of which are over 14,000 feet in height. The foot hills or skirts of this range slope down until within five miles of the western portion of the city. Between Leadville and the range is the undulating valley, four or five miles wide, through which flows the Arkansas river,—at this point a mere rivulet, for its source is at the head of the valley but ten miles distant. The mountains, where they lift their

rugged crests above "timber line," present somber corrugated masses of archæan granite, and in all probability this range has not been submerged by the sea since the original upheaval.

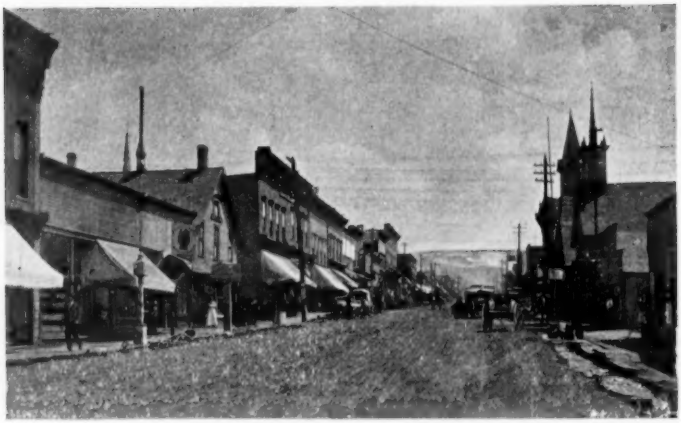
East of Leadville is a parallel range of mountains, nearly as high and prominent as the one on the west, but far more interesting to the miner. Its crests are composed of sedimentary rocks, limestones, shales, and quartzites,—in part the detritus derived from the great granite mountains, and deposited in the sea when the larger portion of this western country was under water. It is in the blue carboniferous limestone of this range, and its foothills sloping down to the town of Leadville, that the great ore deposits of the district are found.

Just to the south of the town is a narrow gulch, running east and west, which has its source in the east range, and, cutting through the most productive portion of the mineral-bearing area, debouches into the Arkansas river valley. This is California gulch, where, in the early "sixties," five or six millions of dollars were taken out in placer-mining, by the most primitive methods of gold-washing,—the pan, rocker, and ground sluice. Along the lower portion of the gulch are the great silver-lead smelters of the district. Leadville, like many other great lode-mining camps, has been established on the site of former rich placer-mining territory.

It was for the purpose of working over some of the low grade auriferous gravel of the gulch that Messrs. Stevens and Wood went to the district in 1874, and discovered and appreciated the value of the masses of carbonate of lead ore, which they proceeded to locate and develop. It was not until the beginning of 1878, however, that any very important discoveries were made, and the district began to attract general attention. In the spring of that year several sales were made at large figures, and the erection of the Harrison Reduction works—the first smelter—was begun. From that time the development of the camp was so rapid, the discoveries so startling, and the business transactions of such magnitude, that even the broadest and most sanguine minds were dazzled, and, failing to grasp the real magnitude of the district, and the vastness of the wealth within reach, rushed to extreme measures. There was no time for sober second thought. Judgment and reason were supplanted by a belief in luck and the advantage of prompt action. The early and many accidental successes led to a somewhat indiscriminate development of the district, sections most



LEADVILLE, COLORADO—VIEW OF THE CITY FROM CAPITOL HILL.



SCENE IN EAST SIXTH STREET, LEADVILLE.

unfavorably situated receiving the same attention as those subsequently shown to contain the best mines. In a comparatively short time a thousand shafts and prospect holes had been sunk on the hills to the east of the city, and then opportunities were afforded for studying the geological structure of the country and the character of its ore deposits. Only then it was discovered and fully demonstrated that the ore bodies rested in great channels or troughs on or in a certain zone, ascertained to be the blue lime stone, in the sub carboniferous formation; also that nature had systematically placed this zone in a position most favorable for the economical extraction of the ore. At intervals of one-eighth to one-half mile the formation was broken through by great meridional fractures, and by compression lifted up or faulted, so that the same ore plane came repeatedly to the surface, very much like the steps of a stairway which had been covered with débris, and brushed down on a regular slope, leaving the outer edges of the flat parts of the step exposed. This condition further helped to distribute the wealth of the district among its many energetic adventurers, as each succeeding rise shut out the discoverer of the vein below when he reached the faulting or uplifting line. It also gave rise unfortunately to much litigation as to titles. Another feature that prevented the district from falling into the hands of a few large corporations, and the retarding of its immediate and rapid development, was the frequent absence of any other covering over

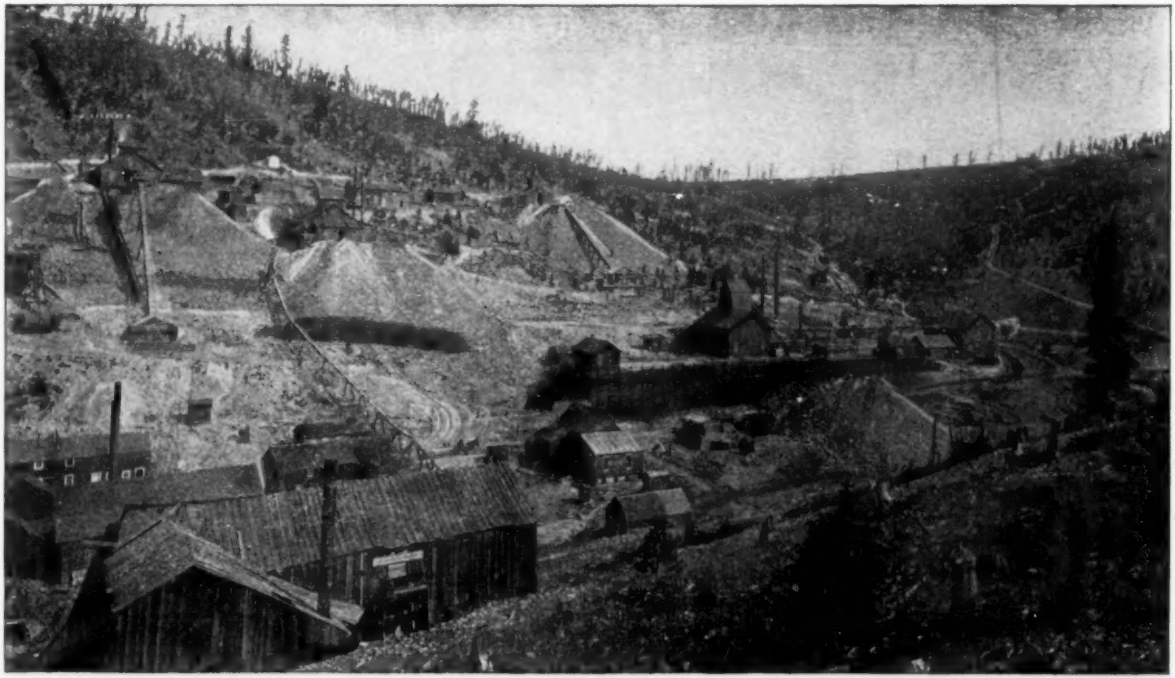
LEADVILLE, WITH MOUNT ELBERT AMD MOUNT MORRISON IN THE DISTANCE.

the rich ore bodies than a few feet of detritus, effectually preventing the establishment of an "apex" and vein in place that could be followed, as the United States laws provide, indefinitely in its course into the earth.

In the spring of 1880 occurred the great strike for reduced hours and increased wages, which reacted most unfavorably for the working classes of the district, as the strike failed, and the occasion was used as a good excuse for suspending work permanently on hundreds of prospecting shafts of no demonstrated value, and of which their promoters were heartily tired. The production was not greatly retarded, however; ore was taken out at a wonderful rate, and four or five millions of dollars were paid in dividends during the year. Up to and including the year 1882, it is doubtful if any ore was raised from a depth of over three hundred feet, and all ores extracted were carbonated or oxidized, in other words, altered by surface water and atmospheric influences, putting them into the best possible condition for smelting as practiced at Leadville at that time.

Beginning with 1885 the conditions began to change, gradually at first, and more rapidly after a time. Greater depth became necessary and the ores became lower in grade and more refractory as the oxidized ores became exhausted and the deeper sulphide deposits were drawn upon. In addition large flows of water were met with. These changes called into play all the ability and re-

LAKE COUNTY COURTHOUSE, AT LEADVILLE.

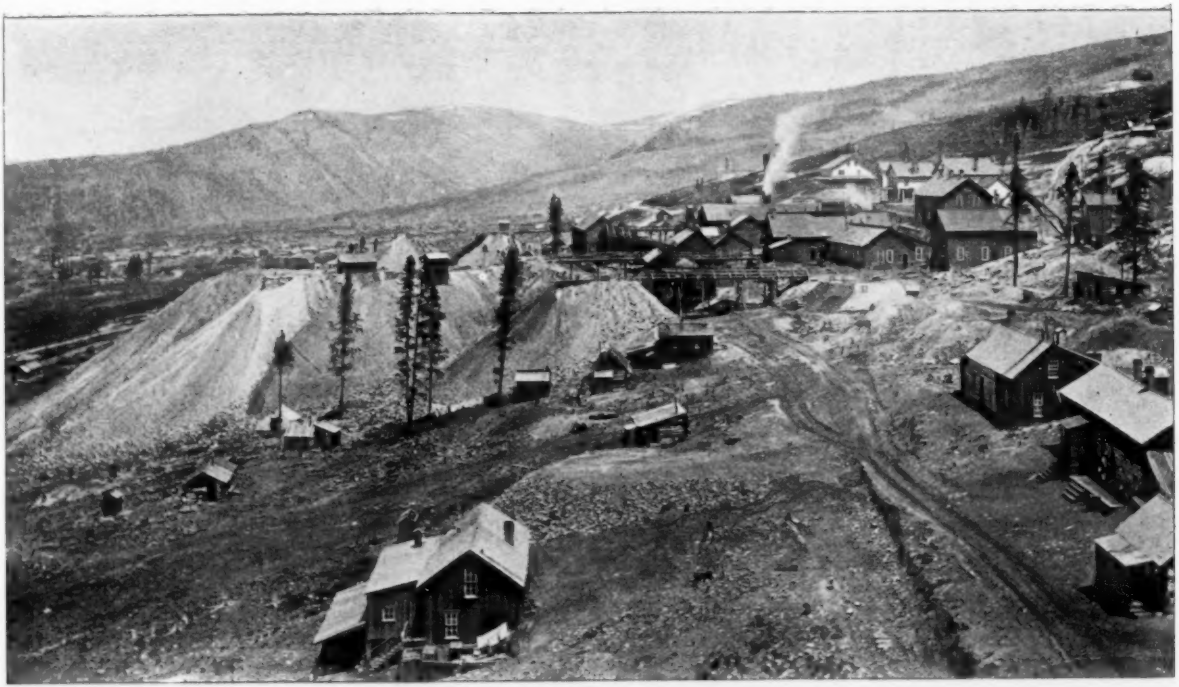


THE SOUTH SIDE OF IRON HILL, SHOWING THE MINNIE AND COLONEL SELLERS MINES.

MAID OF ERIN MINE, WASTE DUMP, AND ORE-HOUSE.

sources of the mining engineer and metallurgist. The speculative element declined, and scientific and practical work was demanded, with large capital to assure success. The era of permanency and stability was ushered in. Enterprises calling for the expenditure of hundreds of thousands of dollars before return could be expected became common, and the result to-day is that Leadville has kept up a production of the approximate value of a million dollars per month, and is on a sound footing and assured of a continuance of an equal production for the next twenty-five years. This steadiness of output rests not so much upon the continuance of bonanza-mining in a few individual mines as upon the opening of new ore-bearing territory, by which the high general average of the district as a whole is maintained. The producing area of Leadville has gradually been extended until the blue limestone has been proved profitably mineralized from Evans gulch on the north to Empire gulch on the south—a distance of four miles—and from the eastern half of the city eastward towards the East or Park range for an equal or greater distance. The area is more or less irregular, but embraces about fifteen square miles, and, as an average mining claim covers less than ten acres, if regularly laid out, there would be room for at least a thousand full locations within the recognized ore-bearing territory.

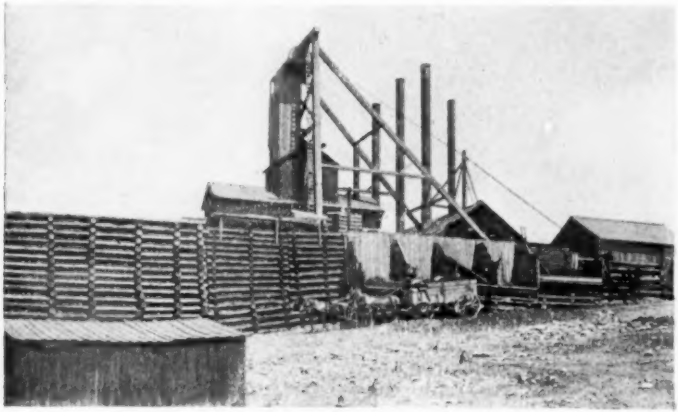
The district is segregated by gulches and elevations resulting in many subdivisions, the majority of which are probably well known



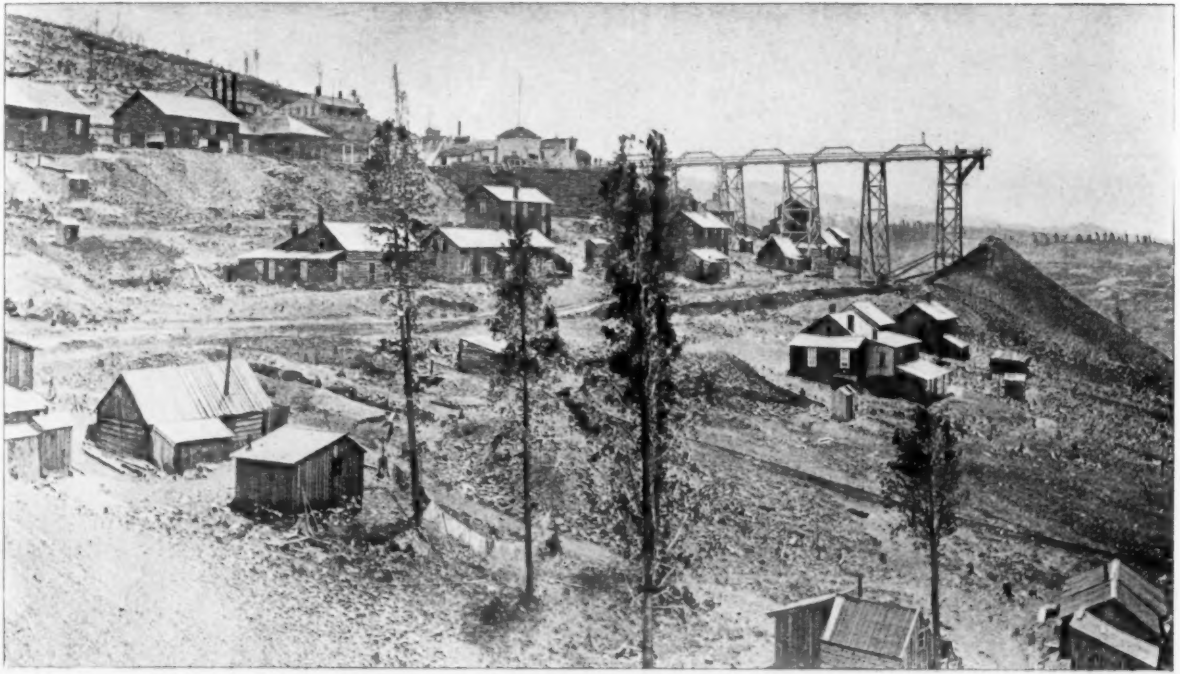
THE IRON SILVER MINE, WEST SLOPE OF IRON HILL.

to many readers by even their local names. Carbonate hill is just east of the city, some of the streets extending well up the slope of the hill where the miners' cottages are intermingled with the shaft-, engine-, and ore-houses of some of the lower mines. North of Carbonate hill is Fryer hill, and east of the latter is Yankee hill, and then Little Ellen hill. Carbonate hill rises to a height of 600 feet above the main street of the town, in a gentle slope. East of Carbonate hill is Iron hill, reaching an altitude of 11,000 feet. Still further easterly, rising up in irregular terraces, Breece hill, Bald mountain, and the range peaks are successively encountered. South of the above described belt are Rock hill, Long & Derry hill, and other local sections, all possessing good mines.

Fryer hill, the most thoroughly worked portion of the Leadville district, and now practically exhausted, is a low rolling hill about 2000 feet in its greatest length and 1500 feet wide. On this little area are located the Chrysolite, Little Pittsburgh, Little Chief, Amie, Climax, Dunkin, Matchless, Hibernia, and Robert E. Lee mines. More than $30,000,000 worth of ore has been extracted from these mines, and dividends of about $12,000,000 paid. No ore was mined at a depth of over 250 feet, the bulk having been taken out at 75 to 150 feet from grass-roots. The surface of the hill now presents the appearance of having been visited by a destructive earthquake. The timbers of the old mines have given way almost everywhere, and the whole surface is broken and sunken



THE NEW PENROSE MINE, LEADVILLE.

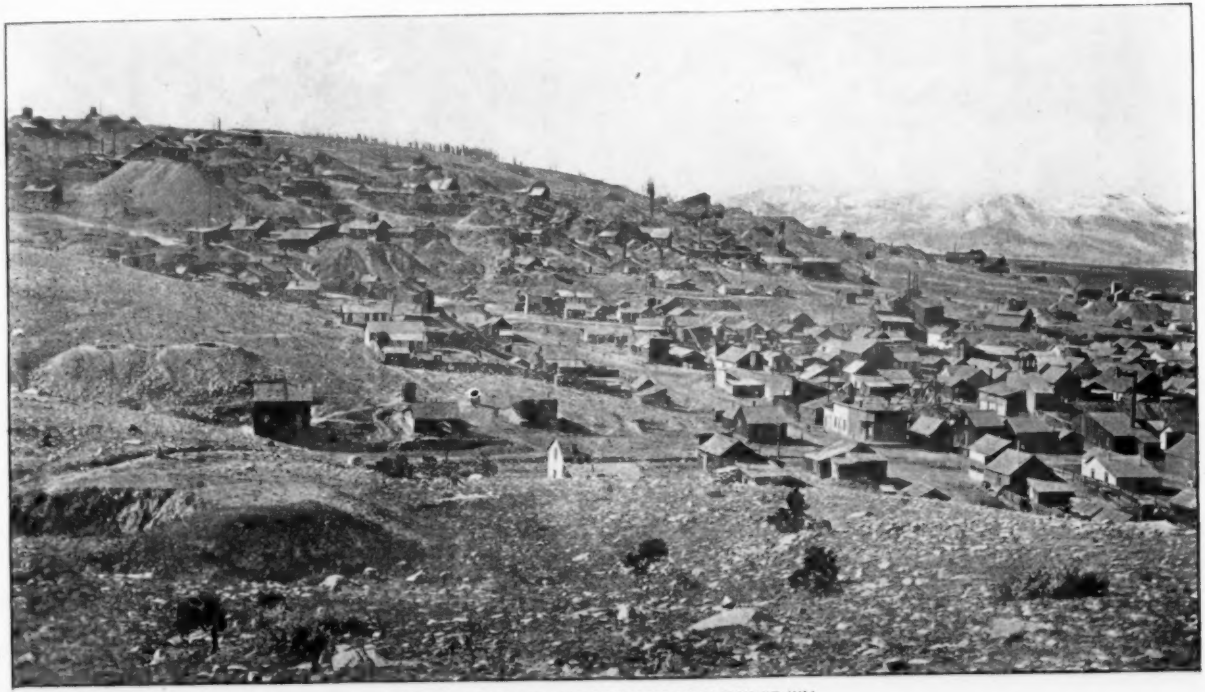


SILVER CORD MINE, ON THE WEST SLOPE OF IRON HILL.

STACK OF BASE, OR SILVER-LEAD BULLION.

and fissured by wide crevices until it is no longer safe to set foot on the greater portion of it.

While Fryer hill is no longer a factor in Leadville's ore production, other parts of the district are still yielding as largely as ever, while a number of localities that were unproductive a few years ago are now producing liberally. Carbonate hill furnishes about as much ore as ever, although the output is largely made by some of the more recently opened mines, while some of the large producers of 1880 have ceased their output altogether. The largest producer on the hill is the Maid of Erin Consolidation, which produces from 5000 to 7000 tons of ore per month, and whose annual yield aggregates over $2,000,000. About half way down the slope of Carbonate hill is one of the faults or displacements of the ore zone, already referred to, where the ore plane is depressed 500 or 600 feet. From this line the ore plane is expected to extend nearly horizontally westward under the town, concealing, beneath the vast superincumbent mass of earth and porphyry, millions of dollars' worth of ore. Three shafts, all within the confines of the city, have lately penetrated to this ore plane, and all have disclosed heavy bodies of rich ore. A number of bore-holes have also been put down to prospect the area. The extent of the ore has not been determined, although a vigorous campaign has been in progress for over two years. The principal obstacle has been the great flow of water encountered. One shaft alone, the Penrose,



LEADVILLE, COLORADO—WESTERN SLOPE OF CARBONATE HILL.

is now pumping 2,500,000 gallons of water per day. The expense is very heavy, but the promise of returns fully warrants even greater outlays. As near as can now be determined, the area west of the fault and extending under the city will yield as much ore as has been obtained up to the present time from the Carbonate hill mines, an amount estimated at $28,000,000. And as Carbonate hill mines were more accessible, and have been worked for fifteen years without exhaustion, the area under the city should be good for twenty five to thirty years' work when once opened up. The other two shafts that are struggling against water, and for a wealth of chloride of silver and lead carbonate ores, are the Bohn shaft and the Sixth street shaft. The latter has already cost its projector, it is estimated, more than $400,000, with no output except a flow of water from its pump as large as a good sized trout stream. The reward, however, is near at hand.

A development of more than usual importance to Leadville is the large body of ore disclosed some months ago in the Little Johnnie mine, on Breece hill. This region is comparatively undeveloped, is very extensive, and gives promise upon further exploration of disclosing many more bonanzas. The Little Johnnie mine has lately begun shipping 2500 to 3000 tons of ore a month. The ore contains a little copper, some lead, runs fair in silver, and contains from $10 to $30 per ton in gold.

The development of the Leadville district, like the growth of a city, has been from a central point, and is rapidly extending in all directions, and no apprehension need be felt that the limits of the district will soon be reached. In addition there still remain large areas in the heart of the producing part of the region that are still unexplored. In fact the amount of ground actually thoroughly opened up or worked out would probably not aggregate one square mile. However, this is an extensive area when the labor involved in breaking and surfacing ores and timbering the workings is considered. Entering one of the larger mines on Carbonate or Iron hill, one can walk half a day and not traverse all the underground workings, as in many sections where the ore is strong drifts are driven at every fifty feet, and the whole mass is blocked out. Frequently also the ore is twenty to eighty feet in thickness, and more, and levels are driven one above the other. The average annual output of the mines now is almost 400,000 tons, gross weight (including moisture). Since the opening of the Leadville mines probably 4,500,000 tons of ore have been mined and smelted.

LEADVILLE, COLORADO—AMERICAN AND ARKANSAS VALLEY SMELTERS.

The large tonnage of the mines, and the great demand of the town and mines for supplies and fuel, early stimulated railroad building, and in the fall of 1880 the Denver and Rio Grande railway reached Leadville. It was followed some time afterwards by the South Park branch of the Union Pacific, and more recently by the Colorado Midland. From 120,000 to 190,000 tons of ore and 30,000 to 50,000 tons of base bullion are hauled annually over these lines, the former paying $4.80 per ton to Denver, and the latter $8 per ton. Leadville is behind many camps of much less magnitude in the matter of local transportation from the mines. All ores are still hauled by team from the mines to the smelters or railway sidings. About 150 teams, all of the heaviest stock to be obtained, are employed. From two to four trips a day are made, according to length of haul, and the loads range from 9000 to 13,000 pounds net. Two of the railways entering Leadville began about ten years ago to build spurs to the leading mines, did considerable grading, and laid some rails, but merchants and others protested vigorously in behalf of the teamster, and railway building was abandoned.

As a result of fifteen years' work, Leadville shows a gross yield, figured upon the actual commercial value of its output, of $183,000,000. Out of this product about 1,600,000 tons was exported to smelters outside of the district, for reduction. The product from the remainder, after smelting, was shipped to Eastern refining-works as base bullion,—*i. e.*, pig-lead bars, containing silver and gold. About 400,000 tons of lead in this form has been shipped from Leadville, which contained approximately 75,000,000 ounces of silver, or over 2500 tons, and about 200,000 ounces of gold, or nearly seven tons of pure gold.

At present the Leadville district has about eighty producing mines, besides about one-third as many prospect properties. On

GOVERNMENT FISH-HATCHERY, BASE OF MOUNT MASSIVE.

these mines, not a few of which have several working shafts, there are about 300 steam hoisting-engines, from the small surface hoist on shallow shafts to ponderous affairs lifting large loads a thousand feet. Boilers aggregating 15,000 to 20,000 horse-power are in use. Coal and petroleum residuum, the latter obtained from the oil-fields of Florence, Colorado, are used as fuel. About 2400 men are employed underground, their wages being $3 per day, and the men average 275 days per year. About 600 men are employed on the surface. The annual pay-roll to surface and underground men at mines amounts to $2,500,000, and the other expenses of the mines to $1,000,000 more, of which about one-half is for imported supplies, such as candles, powder, steel, tools, and machinery. An

estimate of the value of the mining property at Leadville is not easily arrived at. By the eleventh census, the value of mining property in the district was placed at only $27,348,000, of which over $6,000,000 was reported to be in underground developments, about $1,000,000 being in machinery. Under the State law mines are taxed, their valuation being determined by the previous year's production, one-fifth of the gross output of a mine usually being accepted as the proper assessed valuation to be placed on the property.

The smelting industry as now developed at Leadville is equal to that of any other mining district in the world. There are six large and well-equipped reduction-works, having twenty five upright water-jacket furnaces, with an aggregate daily capacity of about a thousand tons of ore. These establishments give employment to some twelve hundred men. In the early days, when the ores were richer in lead than now, and oxidized, the work of reducing the product of the mines was a comparatively easy matter, for then the ore, to use a phrase common at the time, "ran through the furnaces like butter." With the opening of the deep and wet mines, and the change of ore to sulphides, smelting has become a more expensive and slower operation. Great numbers of large preparatory calcining furnaces are now required, in which the ore is first partly desulphurized and thus prepared for final treatment. The water-jacket furnaces are all of the largest patterns in use, being frequently 120 to 140 inches in horizontal length at the tuyeres, and as wide as it is practicable to make them and still allow the blast to penetrate the center of the charge. During the past year a new method of smelting was introduced by the Bimetallic works, whose product is an iron and copper matte, which takes up the silver and gold, and which is subsequently shipped to eastern works for refining. In the furnaces of this establishment heated air is used, which, in conjunction with the sulphur in the ore, supplies the heat necessary to bring about the matting of the ore.

The city of Leadville has a population of about 12,000, and several thousand people more reside on the neighboring hills and gulches. The older residents have begun to like their elevated homes, and are profuse in their praise of the healthfulness of the climate. There is one principal business street in the city, with many good, substantial brick and stone business buildings. The residences are all wooden structures, but many of them are large

and tasteful. There are three large brick school buildings, and the streets of Leadville in the morning and evening are as full of children as any Mormon settlement,—all of them healthy and with voices and lungs that can make themselves heard on hills a mile away. It is hardly necessary to say that there are good banks, live newspapers, electric and gas plants, waterworks, and other modern improvements of the best kind, in this wonderful mountain city.

The average citizen of Leadville is well-to-do. Many are interested in her smelting and mining enterprises, and have been successful. There is another class, in comfortable circumstances, but which makes no display of its means. It is composed of the successful leasers or tribute workers who have followed the operations of the large mining companies, and have taken in the aggregate vast sums of money from seemingly worked-out mines, on which they paid a small percentage. To this class also belongs the successful and energetic contractor. Many of these people are worth from $10,000 to $100,000, but their accumulations are known only to themselves and the banks in which they keep their money.

ELECTRICITY IN THE HOME AND OFFICE.

By Frederic A. C. Perrine, D. Sc.

A WRITER in one of our scientific journals a few years ago, in commenting upon the proposed utilization of the water-power at Niagara Falls, stated that, when the generation of electricity had been cheapened by the use of such great reservoirs of energy, we might hope to see it aiding us in many of the annoying and wearying details of daily life. The housewife would be able to run her sewing-machine without fatigue, our homes would be heated by means of the electric current, the business man would sit in his office ventilated by an electric fan and go back and forth between his home and business on a genuine rapid-transit electric road.

Had such a paragraph been shown to a busy electrician at the time he would have classed it among the many guesses at what "might be"; a "prophesy" if you choose, but hardly worthy of his serious attention.

"Yes," he would have said, "all this is perfectly possible, but you and I will hardly see it; electricity, however produced, costs too much." And perhaps he would have cited to you the famous "electrical-heater" man of the Philadelphia exhibition in 1884 who, by some hook or crook, obtained a space in the Franklin Institute exhibition of that year, but who figured in it most largely as the butt of all the practical jokers among that very lively set of exhibitors.

It was easy enough in 1884 to figure out the losses all along the line from the coal-pile or the waterfall to the heat developed, and prove that this fellow was a fool; but the existence at the present day of several large companies making and selling such apparatus is sufficient proof that he was not, even then, dreaming of impossibilities.

While the eyes of the majority have been turned towards the great central-station lighting plants, networks of electric railroads, or legal battles over the ownership of fundamental ideas, a constant progress has been made in the problem of the domestic utilization of the varied powers of the electric current and its fellow, the oft-neglected magnet.

To-day it is not merely possible to rival the wonders of the

home of Monte Cristo in an every-day office building, or in the fittings of a modern residence where an electric current is available, but a contractor will not be so much as surprised at the elaborate demands you make upon him. He will sit down with his catalogues and, allowing you to choose the particular style of fittings required, will give you an estimate, and to-morrow be ready to put his men at work upon your dwelling putting in place many conveniences you now hardly dream of.

But other such residences have already been completed, and we will see many interesting and ingenious devices for the conveniences of a family should we accept the hospitality of a host who is fortunate enough to have kept himself acquainted with the progress of electrical appliances and to be possessed of a dwelling where the electric current is readily available. Perhaps he prefers burning his coal under the boiler of an engine located in his barn to consuming it in the numerous fires necessary for cooking, heating, and lighting in a country mansion, or it may be that the mains of a central station run near his city house. At any rate he has the necessary current available.

Let us suppose that we have met on a rainy winter evening and have accepted the invitation of this genial host to dine and spend a night under his roof. He knows that we have never before seen a house appointed as his, and perhaps with a touch of pardonable pride he calls into action all the appliances at his command. As we ascend the steps to his front door he pushes aside the escutcheon about the push-button of his door-bell and there are revealed two other buttons, one white, the other black. The white one is pushed, and at once the vestibule door flies hospitably open and at the same instant a flood of light is thrown upon us from an electric lamp placed overhead, which enables our host to find his latch-key and let us into the hall without any annoyance of waiting outside in the rain. As we are removing our coats the host touches a button in the hall which extinguishes the vestibule light and explains that, had he pressed the button disclosed through the escutcheon as a visitor might, he would not only have thrown open the door and lighted the lamp, but would also have summoned a servant to open the inner door and receive our card; but that the two concealed buttons were for the use of the master of the house, so that he could light his way on entering and extinguish the light on leaving his house.

It is a comfort which those who have never enjoyed it are un-

able to appreciate, to live in a house which is completely lighted by electricity and in which the switches are conveniently placed. There is no annoyance in searching for matches in the darkness of an unfamiliar room ; no constant danger as we light our match to ignite the gas of burning one's fingers or of setting fire to the adjacent draperies. But as we enter each room one or all of the lights may be turned on from the outside. There is no convenience in burning any light longer than it is needed, for with the same ease that a gas-jet may be turned up or down an electric lamp may be completely extinguished or brilliantly lighted again. The housewife may delight her friends and family by her dainty conceits of decoration about her lamps and chandeliers with no fear of fires from a breath blowing some light drapery into a neighboring flame. And after spending the evening with his reading lamp in exactly the position to suit his eyesight or whim, the master may retire, and by turning a switch at his bedside cut off all current from entering the building.

But our host, who has just ushered us into his library where his wife sits with the children before a blazing wood-fire, is possessed of many luxuries besides this great one of complete lighting. There is yet time in the afternoon for a cup of tea before dinner is announced, and the maid soon enters with the tray, which she places before her mistress and, after adjusting the plug attached to a flexible cord leading from the water kettle into a socket in the wall near by, departs. Then our hostess, having turned on the current by a switch at her hand, asks each his preference as to cream and sugar, and by the time the cups are arranged ready for the tea-making the water is boiling furiously, and soon we sit down for our chat, each holding a steaming cup of tea made from water which has never been approached by fire. As the talk proceeds, touching now upon the rare books, china, and silver on the library shelves, the thought occurs to me that extraordinary precautions are needed here to protect against burglars, and, on inquiring concerning this, we find that here also electricity has aided in making comforts for the head which wear the crown of magnificent possession.

Should a door or window or shutter of the house be opened or a leaf or drawer of a cabinet be tampered with in the night, at once the room intruded upon becomes brilliantly illuminated by a lamp which is set in the ceiling and out of reach to smash ; in the master's room a light springs up at the ringing of the alarm bell, and the news of the intrusion is at once telegraphed to the nearest

police station. Should the burglar attempt to escape through the house, he must light room after room as he opens the doors.

Against a fire, too, these elaborate fittings have provided whatever protection man has devised against that all-destroying fiend, and it is at least possible to aid the exit of the unfortunate inmates of a burning house. In each room are several of what are called "thermostatic push-buttons,"—little devices which close and keep closed an electric circuit whenever the temperature of the apparatus rises above a certain amount. When this occurs in any room, at once every room in the house is lighted, bells ring loudly in all the bed-rooms, and at the same time the nearest fire-alarm box is automatically pulled and the alarm sent in. Help is brought at once, but, above all, those who are escaping from the burning building are not still further imperiled by confusion in the darkness.

But as the narration of these wonderful appliances has been completed dinner is announced, and we are ushered out to a meal cooked, and well cooked, but not by coals on fire. There are no burned spots on the meat, nothing scorched and nothing underdone, but the cooking is rather of the order of perfection of a dinner prepared in the old, evenly heated brick ovens. The electrical baking-oven, in which this meat has been so perfectly prepared, is heated entirely from the inside, and by asbestos packing and burnished external surfaces all radiation to the outside air is checked, so that the heat generated is entirely used in the operation of cooking.

External vessels seated on the top of the stove are not generally used in cooking by electricity, but each sauce-pan, kettle, frying-pan, griddle, or broiler is provided with its own electrical heater, and only while cooking is being done is any current used in a particular utensil. On the table itself the chafing-dish is provided with an electrical heating device, and to-night our host turns the current on the coaster for a few minutes to warm the claret which has yet the cellar chill upon it. We find, as we talk of these things, that even the fair daughters bless the advent of electricity at their dressing-table, for by its aid they are relieved from the smoke of gas or the annoyance of an alcohol lamp in heating their curling irons, while they are never annoyed by a light which cannot be moved and made to shine in some one fold of the gown.

While we have thus been chatting of these appliances, dinner has been completed, the evening far spent, and we make ready for

retiring with the final instruction from our host that we should set the thermostat over our beds at the temperature at which we desire to sleep, and the electrical heater just under the window will warm the incoming air and give us a constant temperature to foster pleasant dreams. We need have no fear of fire or waste of current, for the thermostat will shut off the current as often during the night as the temperature rises above that which we desire.

The successful introduction of the various electrical cooking and heating devices has been dependent upon the invention of apparatus for transforming electrical energy into heat which should be at the same time efficient, convenient to use, and durable. When the "electrical-heater" man of 1884 was made the subject of ridicule and the butt of the practical jokers, it was mainly because his apparatus as it existed did not and could not solve the problem. He had packed a lot of German silver wire in powdered lime and was vainly fancying to himself that he was possessed of a practical piece of apparatus. But his wire was large and long, and the protection that he gave it did not prevent its being gradually oxidized and finally destroyed. So that, while he may have contributed to the knowledge of the necessities in electrical heating, it was not a practical commercial possibility till the idea of excluding the air from the hot wire by an enamel baked on it or a coating of cement became developed.

To review the various operations requiring heat and to devise apparatus in which we can use the electrical heater in performing these operations is simply a matter of design, but to day we can say that cooking by electricity is a practically possible thing, which it was not by any means before the invention of a successful electrical heater.

Just here, however, the important question arises of the economy and cost of this radical departure from the ordinary method of procedure in these well established operations of the household. That there is a real economy of energy I do not believe any one would be able to doubt if the electricity be generated in a station where the engines are not consuming over three pounds of coal to the horse-power. For estimating all the losses in the dynamo at about 15 per cent., in the mains at 5 per cent., and in the heating apparatus at not more than 10 per cent., we have a total efficiency of about 70 per cent. of the power of the engine transformed into heat and used in the cooking by the electrical heater, or, taking into account the efficiency of the engine, approximately 11,000 foot

pounds for three pounds of coal, which is an efficiency of about twenty-five per cent. But even this great loss is much less than can possibly be obtained by firing the coal under a cooking-stove, where the best results ever obtained do not give an efficiency of more than 6 per cent. Still we must not forget that the coal which costs us $5 or $6 a ton when delivered into our cellar ready to be consumed in the cooking-stove cannot be delivered to us at any like cost when its potential energy has been transformed by a boiler, engine, and dynamo into electrical energy and delivered at our cooking table over the mains of the electrical-supply company. We must pay for our conveniences in interest on the great plant necessary for their conversion as well as in salaries of all those employed, as also we must reward the capitalists investing in the apparatus by dividends on their stock.

On the other hand not only have we the actual saving in the transformation of the potential energy of the coal into heat energy by this chain of changes, but also we must take into account the fact that with an electrical cooking device no fire need be prepared for hours before it is in the proper condition for cooking and maintained constantly after these operations are completed, but the heat rises within a few minutes after the current is turned on, and when the switch is turned off no further current is consumed.

Experiments have been made on the cost of cooking in this manner by an English electrician, and he states in a most elaborate paper the cost of toasting a slice of bread or of boiling an egg, but no such results can be of much value in determining at what cost our own servants are able to perform these operations. That the cost at present is not as great as by gas cooking seems well established, and we may hope soon to have reliable results from the practical operation of some of the recently established electrical kitchens.

But now it is morning, and we must not forget that to-day we are to visit our host's office, where he has further electrical wonders for our inspection. Our bed-room lamp lights itself promptly at rising time, and, dressing ourselves by its light, we descend to breakfast, where further use is made of electrical heating in preparing our coffee and eggs ; but at last we must bid adieu to the hostess and her ever ready slave, electricity, to visit our friend at his place of business.

He is a busy, hard-worked man, and has his office spread over half a floor in one of our tall office buildings; under his control are

many sub-departments and numbers of clerks driving along that great mental engine, the financial department of a large business.

Entering the building, we are at first conducted to the basement, where we find an electric-light station capable of furnishing lights enough for a small town, but which has only sufficient power for generating the current required in this one building.

While we are admiring the great engines and bright tiled floors and walls of the dynamo-room, we must not allow the mechanism of the electric elevators to escape our eyes. There are two styles of these machines near us, operating different cars. The older of the two is arranged like the hoisting engines which are to be seen on every dock and in every freight yard, with the single difference that in place of a steam-engine driving the drum on which the hoisting rope is coiled there is an electric motor, the shaft of which is connected with the drum through a train of gearing to reduce the high speed of the armature shaft in order to give the proper revolution speed to the winding drum.

But the later form of elevator mechanism is far more novel, though somewhat resembling the mechanism of a hydraulic elevator. To the shaft of the electric motor is connected directly a very long screw on which is a large nut running between guides and carrying a set of iron grooved wheels. Over these wheels and over a corresponding set of stationary wheels at the end of the machine the hoisting rope of the elevator is passed, making as many complete turns as there are pairs of stationary and movable sheaves.

When now the current is turned on and the motor moves, the screw revolving with the armature carries its nut either forward or back. If the motor moves forward and the nut carrying the sheaves moves away from the stationary sheaves, the rope is drawn out between them and the car ascends; but if the direction of the motion is reversed and the sheaves are moved nearer to each other, the car falls just as it would had the power been hydraulic in place of electric. Here, too, in one corner of the cellar is a large fan driven by electricity, which forces either hot or cold air—according as the register may be turned—into all the rooms of the building through a double set of pipes, through one of which the air passes over coils carrying the exhaust steam from the engine.

But now taking the elevator to our friend's office, we find many conveniences to lessen the labor of a busy day ready at his hand. We at first notice that this desk lacks the usual array of push-buttons for calling the heads of departments which are so much in

evidence in many desks and are so confusing in a large office. But on our remarking their absence it is at once explained to us that the little dial which we see among the pigeon-holes in the front of the desk has the name of every man in the office printed upon it, and, when the pointer attached to the hand over the face of the dial is above a man's name, pushing the button in the center of the dial will call the clerk desired.

"This 'teleseme,' as it is called, is convenient when I wish a man to come to me," explains our friend, "but I seldom use it, for this device here is better." And turning to his telephone he explains the latest desk switch-board.

Many offices have been fitted with telephones from desk to desk with their wires leading to a central exchange where an operator sits to make connections from one to another, but with this device each one has complete control of the wires over which he is talking. A contact plug is attached to the telephone, and on the desk is arranged a bank of plug holes and annunciator-drops connecting with each man in the office who has a telephone. Pushing the plug into one of the plug holes and pressing a button calls the clerk to his telephone, while, if it is desired that the clerk be not allowed to call his employer, the corresponding annunciator-drop is omitted from the employer's desk. In this way a chief may arrange to call or be called by just those of his subordinates he may desire. Should he desire to talk to two or more clerks at the same time, he has but to call them up, and, changing his contact plug from one hole to another, talk to each without possible interference from the others who are waiting till he speaks again ; thus permitting conversations, consultations, and cross-questionings without obliging any of the participants to move from their desks, and without disturbing the telephone communication of the rest of the office.

But the electric dial which tells the correct time being actuated by the great self-winding clock in the hall below tells us that we have already taken much of a busy man's morning, and now, much impressed by the ingenuity of these devices, great and small, we leave him dictating the letters of the day to his phonograph.

Hardly realizing that this man may yet before the day is out be talking to a business house in Chicago, hearing that his commission given a few minutes ago has been executed in Australia, or writing a letter which is at once reproduced in his own handwriting in Boston. All of this, too, without leaving his office or even moving from his desk.

THE DEVELOPMENT OF THE MODERN STEAM PUMPING-ENGINE—II.

By William M. Barr, M. Am. Soc. M. E.

IT has always been a favorite project, especially in pumping operations, to convert intermittent into continuous, and reciprocating into rotary, motion. Serviere, a Frenchman, born in 1593, made during his lifetime a large collection of mechanical models, and among them were included machines for raising water. The rotary pump illustrated near the end of the previous article was included in this collection ; it is the oldest, simplest, and in some respects the best rotary pump yet devised, consisting only of two toothed wheels gearing into each other. The water, entering in the direction of the arrow, passes around the peripheries of the wheels to the upper center, and is there prevented from returning by the contact of the wheels. These wheels are sometimes made up of segments of two radii so arranged that one extended segment shall roll into the opposite space, thus affording larger water spaces around the periphery of the wheel, the exact centering of these segmental wheels being secured by toothed wheels keyed to the driving shaft outside of the case.

The rotary or revolving piston pump has one good quality in common with the centrifugal pump in not changing the direction of the flow of water; which permits a high speed of revolution of the geared, or other form of piston. This continuous flow through the pump dispenses with the necessity for either inlet or discharge valves, making it a simple and effective pump for handling perfectly clean liquids.

The designs for rotary pumps are very numerous, a favorite one being the movement of a sliding piston through a turning block located eccentrically to the interior of the pump. In other designs two or more sliding pistons are employed which slide into, but do not pass through the turning block ; but whatever the design there is usually such a complication of sliding parts, levers, etc., that the pumps are costly to make, and are not always durable in service. As compared with the centrifugal pump, the rotary pump has the advantage of being able to force water under a high

pressure, and for this reason pumps of this class have long been in favor as fire-pumps, not only for factories, but mounted on wheels like other steam fire-engines.

The principal objection to the rotary pump is that, except when new, it does not have a high efficiency—scarcely more than 50 per cent.—at best; and this is quickly lowered by the destructive wear occasioned by contact action of the revolving pistons upon each other and upon the case. This wear soon makes them noisy as well as leaky; and by reason of the wear upon the interior of the case, it can be repaired only by reboring; and this often necessitates furnishing new pistons as well. Nor are rotary pumps, in general, well adapted for gritty water, especially when the pump consists of two toothed wheels working together. Water containing floating matter such as would pass through a centrifugal pump unnoticed would not pass through a rotary pump (excepting only a very few of special construction) without danger of breakage.

The low efficiency of rotary pumps has been explained as arising from the inertia of the water, or the difficulty of putting the water in motion from a state of rest, and imparting to it a high velocity as it passes through the pump, thus requiring the expenditure of more power than is later represented in useful effect.

To the famous mathematician Euler probably belongs the honor of having invented the centrifugal pump; but no immediate application of it seems to have followed the publication of his paper on the subject in 1754. The modern centrifugal pump is probably of American origin, one having been erected by Mr. McCarty in the navy yard at New York, in 1830, which was subsequently improved upon by Andrews in this country, and Appold, Thomson, and Gwynne, in England.

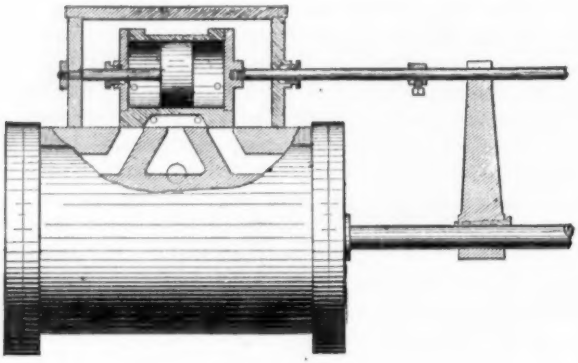
All centrifugal pumps are constructed upon one general principle, consisting of a fixed case within which revolves a "fan," the water entering at the center and being discharged at the periphery of the fan blades into a spiral chamber which terminates in a delivery pipe tangent to the fan-circle. The blades of the fan were originally straight and radial. At the great exhibition in London in 1851, Appold introduced his centrifugal pump, in which the blades were curved backwards, with the result that nearly three times as much water was discharged as was the case when straight blades were used. Since that time curved blades have been universally adopted.

Centrifugal pumps are best adapted for handling large volumes

of water on low lifts, and are now almost wholly confined to such service. By reason of their extreme simplicity of construction, pumps of this kind can be made at lower cost than any other yielding similar delivery. The flow of water through a centrifugal pump is continuous, and the velocity nearly uniform; the entire absence of reciprocating parts, valves, and the like, enables the "fan" to be run at a high rate of revolution. There is a speed at which each pump will a little more than balance the weight of water between the lower and the higher or discharge levels. With this as a starting point, it is to be expected that an increase of velocity will give an increased discharge, but observations show that the increase does not follow directly as the speed, the economical lift and delivery being reached when the atmospheric pressure is wholly utilized; that is to say, when thirty-four feet of total lift is had. For purposes of irrigation, drainage, emptying of docks, coffer-dams, and excavations generally, these pumps are well suited, partly because of the large volume of water that can be transferred quickly, and partly because sand, gravel, stones, sticks, etc., will pass through centrifugal pumps without the liability of accidents to which other forms of pumping machinery are liable.

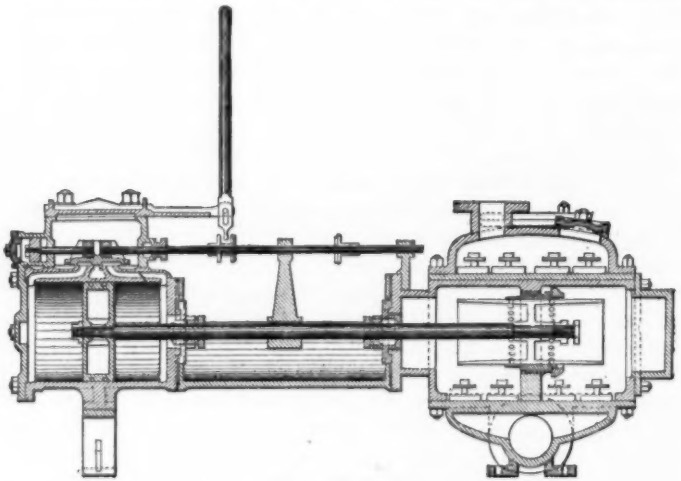
The efficiency of centrifugal pumps, obtained by dividing the water horse-power by the indicated horse-power, rarely exceeds 65 per cent. The engine for operating may be either simple or compound, depending upon the size of the pump, the permanence of the work, and the value of the fuel used. For lifting a large volume of water to a moderate height the centrifugal pump stands unrivaled in point of simplicity, compactness, and low first cost; but in point of durability and percentage of efficiency it does not equal the reciprocating pump.

The direct-acting steam pump, if we except Bull's Cornish pump, is an American invention, the credit belonging to the late Henry R. Worthington, who patented in 1841 a direct-acting steam pump. This patent covered a method of operating the slide valve without the aid of the momentum of moving parts. In addition to moving the water under pressure the steam power was exerted in compressing a spiral spring, through a suitable mechanism, without disturbing the steam valve, until the piston reached the end of the stroke; then the spring was released, the valve moved to the other end of the steam chest, uncovering the opposite ports and reversing the action of the engine, when a corresponding compression, release, and reversal occurred, making the engine automatic.

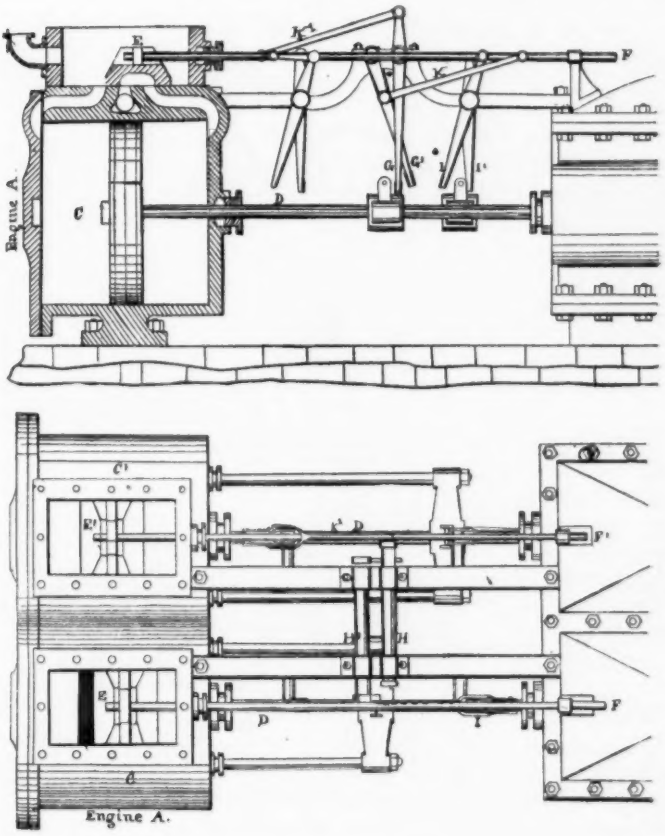


STEAM-THROWN VALVE.

As might have been expected, such a crude device as this could not long satisfy such a man as Mr. Worthington ; and his next invention was the employment of a small steam piston for moving the main steam valve, as shown in the engraving. This auxiliary piston was acted upon by an auxiliary valve not shown in the diagram, an omission easily supplied by the reader. From this time forward steam-thrown valves for direct acting engines were



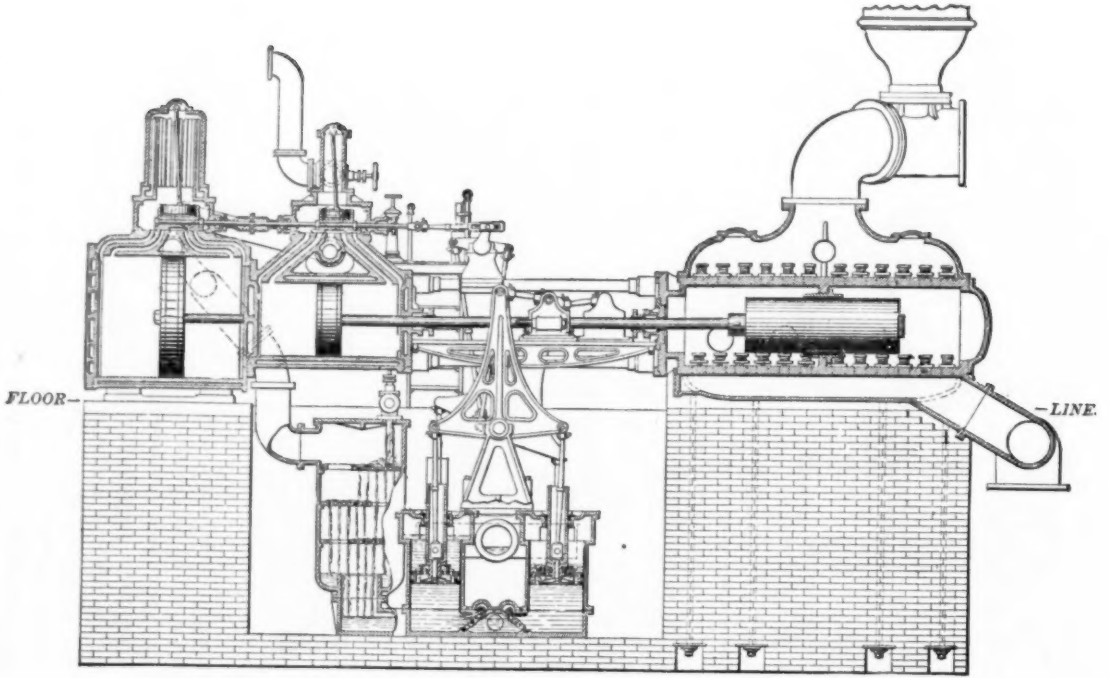
B SLIDE VALVE WITH POSITIVE MOTION.



ORIGINAL DUPLEX VALVE MOTION.

plentifully designed, and patents issued in great number, some being of considerable merit, others less so.

Ingenious and sufficient as was this steam-thrown valve motion, it was soon abandoned by its inventor, through an incident related by him which is well worth repeating. Mr. Worthington enjoyed the friendship of two eminent engineers of his day,—James P. Allaire and Arthur Stillman,—each of whom manifested considerable interest in the new pump, and upon its completion examined it with great care. Mr. Allaire nearly reduced his friend, the in-



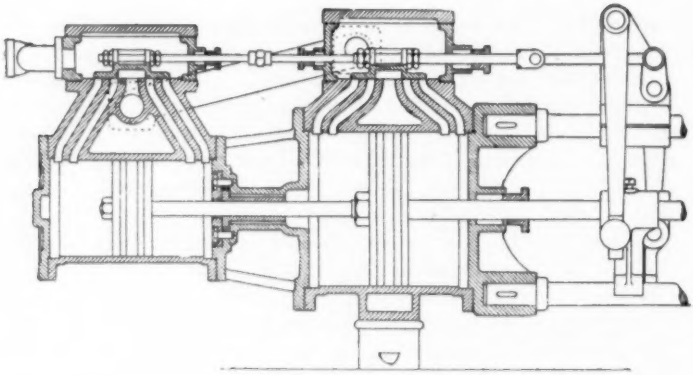
COMPOUND CONDENSING ENGINE.

ventor of the new pump, to hopeless inaction, by saying that "he considered it his duty to tell him that he was trying to invent a machine that was not wanted; and that no part of the machinery either of steamboats or for factory purposes was more satisfactory and complete than that for pumping." Nor did he fare better through the advice of his friend Mr. Stillman, who said, "This is all very well, and very ingenious, but, if you expect to bring these things into general use, you must contrive to have a man see something he has seen before in his life, when he takes the cover off from the steam chest." This well-meant advice was conclusive, and Mr. Worthington immediately set about inventing another valve-motion, which he patented in 1849, one which fully met Mr. Stillman's suggestion. This valve-motion, in its modified form, is shown in the engraving; the *B* or double cavity valve was probably first used on this pump.

Other builders of direct-acting steam pumps did not share Mr. Worthington's anxiety in regard to the future of the steam-thrown valve; the popularity of the Knowles steam pump, for example, more intricate in its detail than Worthington's, steadily grew, in face of the fact that engineers did not then understand its construction; and, in general, it is doubtful whether this valve motion is any better understood to-day; the superior excellence of workmanship alone, by which was insured certainty of movement, more than anything else carried this pump over the first quarter of a century after its introduction.

The Duplex steam pump and valve motion, as patented by Mr. Worthington in 1859, is herewith illustrated. To one who has not analyzed its peculiarities, there is no seeming resemblance to that of the duplex pump of to-day; but it is, in all essentials, the same. Steam cylinders with five ports, the two outer ones for the steam, and the three inner ones for the exhaust, were added later, and with this addition the duplex pumping-engine became practically a perfected machine.

A direct-acting engine without any provision for using steam expansively must, from the nature of the case, be extremely wasteful of fuel. Economy, then, compelled the use of compound steam-cylinders, especially for city water-works and other large installations. An illustration of such an engine is given opposite, together with the condensing apparatus and air-pumps. Engines of this class, compound condensing, of about ten million gallons daily capacity (24 hours), using steam at 90 pounds boiler pressure,



TANDEM COMPOUND VALVE MOTION.

with three expansions, will yield an average duty of about 60,000,000 foot-pounds for each 100 pounds of coal burned.

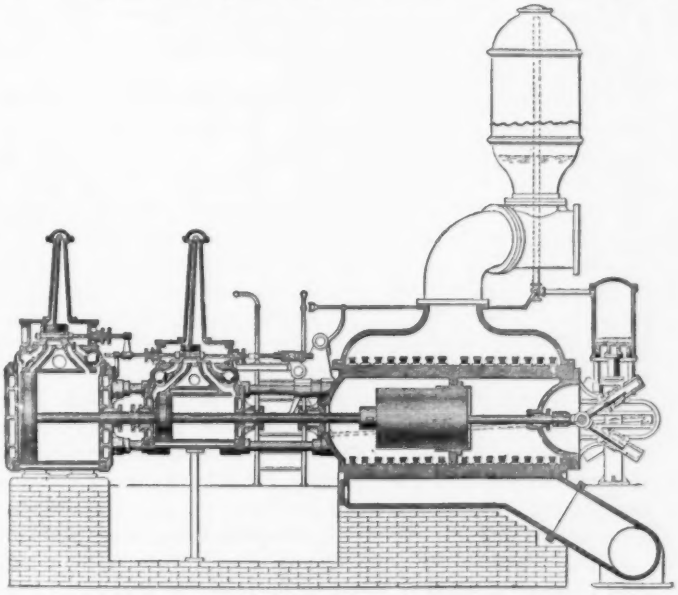
For smaller engines, say two millions of gallons in twenty-four hours, the steam-cylinders are commonly arranged as shown in the engraving. Engines of this size are not always fitted with condensing apparatus. The low-pressure cylinder ranges from two to three volumes that of the high pressure. The steam pressures are commonly from 75 to 90 pounds at the boiler. The duty of such an engine, when non-condensing, is about 25,000,000 foot-pounds per 100 pounds of coal burnt.

What is true of the duplex pumping-engine in the matter of duty applies equally to all forms of direct-acting engines in which steam expansion can only be secured through the medium of high and low pressure cylinders using steam full stroke. The low duty of this class of engines is due to the want of a suitable mechanism by which a greater degree of expansion may be secured, and which for many years was not believed to be possible. For this reason the attention of engineers was almost wholly withdrawn from engines of this type, and directed toward some other form, especially the compound condensing rotative engine, fitted with either an adjustable or an automatic cut-off; engines in which could be utilized the well-known properties of the fly-wheel, securing thereby the advantages of a higher steam pressure and a greater degree of expansion. It was also believed that certain economies would accrue if a higher ratio of piston speed to that of the water plunger

were employed. The compound pumping-engine of five million gallons daily capacity, designed by E. D. Leavitt, and erected at Lynn, Mass., in 1873, was of the crank and fly-wheel type ; and it greatly surpassed, at the time of its erection, the duty of any pumping-engine ever erected in this country ; the officially reported duty being 103,923,215 foot-pounds of work done for every 100 pounds of coal fed into the furnaces.

This remarkable performance was exceeded by a compound pumping-engine, also of the crank and fly-wheel type, of three millions of gallons daily capacity, designed by George H. Corliss, and erected at Pawtucket, Rhode Island, in 1878, the official report of a 24-hours trial being that 133,522,060 foot-pounds of work were accomplished for each 100 pounds of coal burnt.

A compound crank and fly-wheel pumping engine designed by H. F. Gaskill, erected at Washington in 1888, with a capacity of 2,500,000 gallons in twenty-four hours, yielded 101,772,977 foot-pounds of duty per 100 pounds of coal burned. Larger engines on this same general design have given better results than the above.



HIGH DUTY DIRECT ACTING PUMPING-ENGINE.

The advantages of high steam-pressure, and the corresponding number of expansions which may be secured, were well illustrated in a pair of triple-expansion crank and fly-wheel engines designed by Edwin Reynolds, and erected in Chicago in 1890, the combined pumping capacity of the two engines being 10,000,000 gallons in twenty-four hours. A net duty of 137,608,346 foot-pounds of work done per 100 pounds of coal burnt was the resultant record when the initial steam-pressure was 125 pounds. The water used was 12.675 pounds per indicated horse-power per hour.

To return to the direct-acting engine after quoting such figures is accompanied by something akin to weariness; but mention must be made that inventors were engaged upon the problem of securing a high-duty attachment for the direct-acting engine, by which its economy should be greatly increased even though it fell short of the highest duty of the compound crank and fly-wheel engine. Such names as Morrison, Cameron, Davies, Davey, Fielding, Blake, D'Auria, Groshon, and especially C. C. Worthington, son of the late Henry R. Worthington, deserve especial mention. To Davey, in England, and Worthington, in this country, is due high praise for the intelligent and vigorous manner in which their inventions have been pushed toward completion.

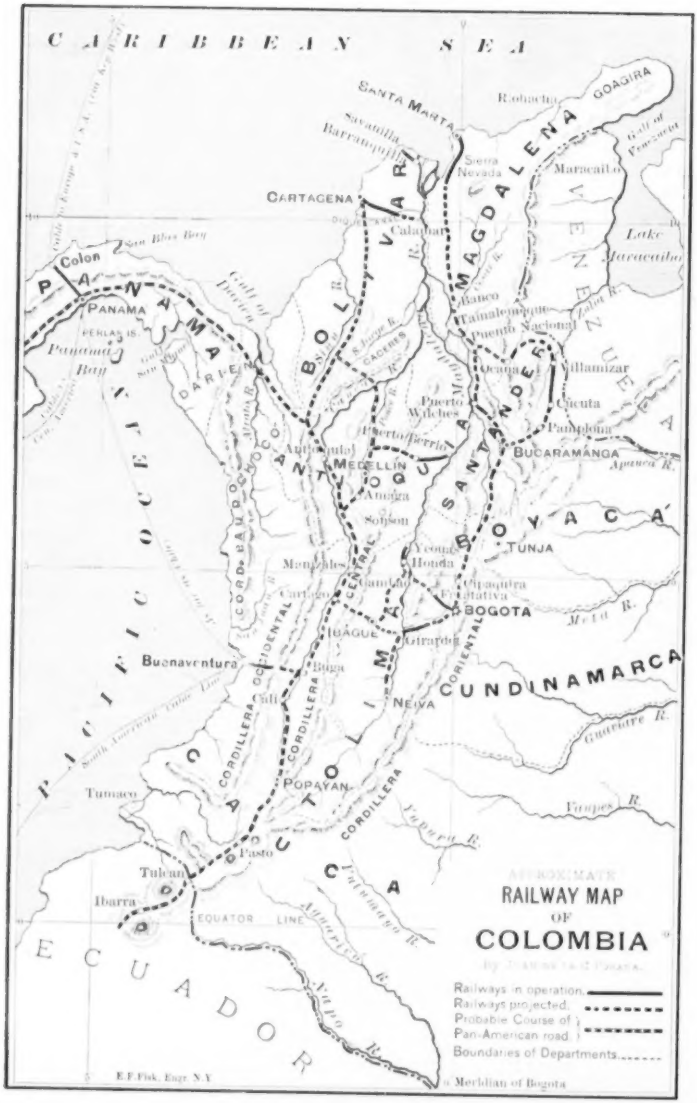
A remarkable adaptation of the Worthington direct-acting high-duty pumping-engine occurs at Olean, Pennsylvania, in one of the pumping stations of the Standard Oil pipe-line. It is a duplex engine of the Tandem compound type. The steam-cylinders are 33 and 66 inches in diameter, the pump plungers 9¼ inches in diameter, all of 37⅝ inches stroke. The work required of this engine is to pump about 1,250,000 gallons of oil in twenty-four hours, against an average pressure of 860 pounds, but which sometimes reaches 900 pounds per square inch. The boiler pressure is kept at about 90 pounds; the average steam pressure during admission to the high-pressure cylinder is 74 pounds;—average piston travel 126 feet per minute. The foot-pounds of duty per 100 pounds of anthracite coal at average rate of evaporation, under working conditions, were 110,943,000. If the boilers had evaporated ten pounds of water per pound of coal, the duty would have been 116,500,000 foot-pounds. The total indicated horse-power was 457, the water consumption was 16.4 pounds per indicated horse-power per hour.

A compound duplex pumping-engine with Worthington's high-duty attachment, made in England, the principal dimensions being 27-, and 54-inch steam-cylinders, 40-inch plungers, all of 44-inch

stroke, indicating 255.5 horse-power when delivering 13,407 English gallons per minute, on the unusually low lift of 53.68 feet, gave a duty of 106,010,000 foot pounds of work for each 112 pounds of coal burnt. The mechanical efficiency of the engine and pump was 0.8495. The piston speed was 124 feet per minute. The feed-water was 14.9 pounds per indicated horse-power per hour.

From the above it will be seen that the direct-acting engine with high duty attachment is now fully abreast its once formidable rival, the crank and fly-wheel engine, and that under similar and average conditions the economy of each may be assumed to be equal.

No one knows what a day may bring forth. The present indications do not point to a speedy adjustment of the difficult problems of deep-mine pumping, in which the resources of the steam engineer seem to be well-nigh exhausted. Electricity, working wonders in so many directions, in its practical applications does not yet promise economical results in mining-pumps beyond those now attained by steam. Compressed air as an agent for the removal of water from mines is wanting in sufficient and accurate data upon which to venture an opinion as to its future. For water-works supply the mechanism of pumping machinery is on a high plane of excellence and economy. Two distinct types—the direct-acting and the rotative high-duty engines—will compete side by side with about equal claims for high economy; the water-ends, provided with mechanically operated valves, practically solve that problem.


CARIBBEAN SEA
SANTA MARTA
Barranquilla
GOAJIRA
Riohacha
Sierra Nevada
Maracaibo
Gulf of Venezuela
CARTAGENA
Calamar
MAGDALENA
Lake Maracaibo
Colon
San Blas Bay
PANAMA
PANAMA
PERLAS IS.
Panama Bay
Gulf of Darien
DARIEN
BOLIVAR
Banco
Tamalameque
Puerto Nacional
Ocaña
Villamizar
Cucuta
Puerto Wilches
Puerto Berrio
Pamplona
BUCARAMANGA
Apaneca R.
ANTIOQUIA
MEDELLIN
Amalfi
Amaga
Sonson
SANTANDER
BOYACA
Yeguas
Honda
TUNJA
Manizales
Armenia
Quipaquira
Fusagasuga
BOGOTA
Meta R.
IBAGUE
Girardot
Buenaventura
Buga
CUNDINAMARCA
NEIVA
Guayabero R.
Tumaco
POPAYAN
Pasto
Tuluan
Ibarra
EQUATOR LINE
Putumayo R.
Caqueta R.
Yapura R.
Vaupes R.
ECUADOR
CORDILLERA OCCIDENTAL
CORDILLERA CENTRAL
CORDILLERA ORIENTAL
PACIFIC OCEAN
South American Cable Line
APPROXIMATE
RAILWAY MAP
OF
COLOMBIA
By Frederick H. Evans
Railways in operation
Railways projected
Probable Course of Pan-American road
Boundaries of Departments
E.F.Fisk, Engr. N.Y.
Meridian of Bogota

RAILROAD DEVELOPMENT OF COLOMBIA.

By Juan de la C. Posada, B. S.

THE accumulation of capital in the United States, the development of industries until the home demand for their products has been more than supplied, and the crowding of the professions, have combined to create an interest in the prospecting of other countries, where some of this extra energy, as it were, may profitably be expended. Latin America, with its immense and varied fields for enterprise, is attracting a share of this attention. It gives me, therefore, much pleasure to comply with the invitation of the editor of this Magazine to contribute something toward a better knowledge of my native country, the Republic of Colombia, and the opportunities for engaging in business in this rich section of the world.

Colombia embraces an area of over half a million square miles, with upwards of 2500 miles of coast-line on the Caribbean sea and Pacific ocean. Just at the beginning of the war of independence, in 1810, the population was estimated at 1,000,000, and shortly after the end of that sanguine struggle, in 1825, the census returned 1,223,598 inhabitants. In an accompanying table is shown the growth of the country in population in the period between 1843 and 1881, and the area of the several political divisions—called "Departments" since 1886—which compose the republic of

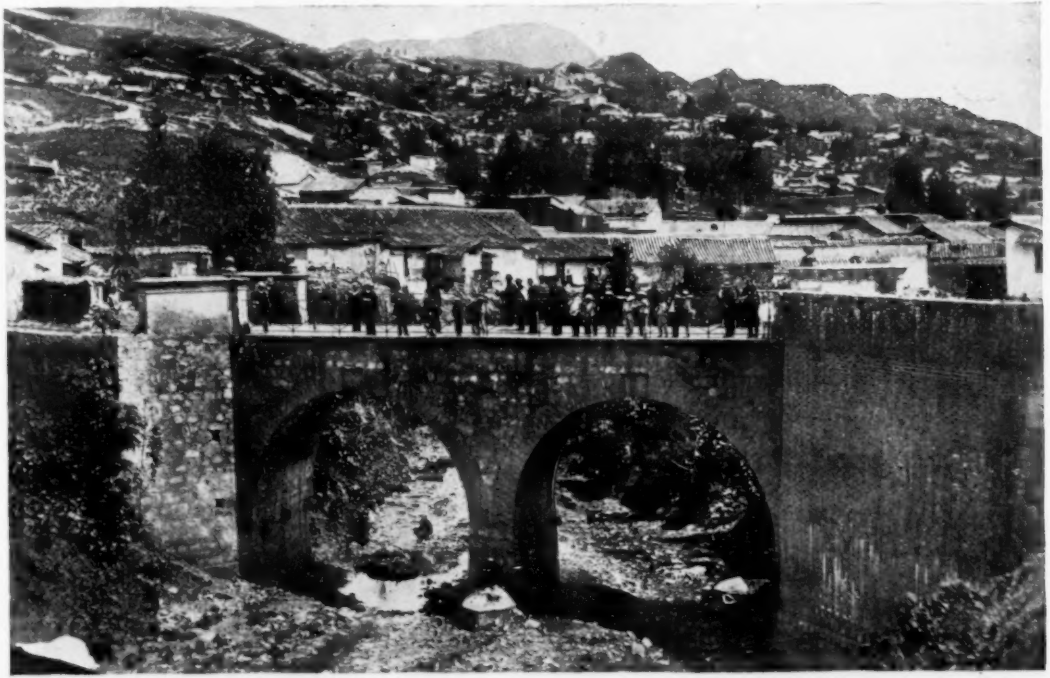
Department.	Population 1843.	Population 1881.	Area in square miles.	Inhabitants per square mile.	Number of years to duplicate the population.
Antioquia.....	189,000	470,000	22,790	20.7	25
Bolivar.....	192,000	320,000	27,027	11.9	56
Boyacá.....	332,000	666,000	33,321	19.4	37
Cauca.....	268,000	614,000	233,132	2.7	30
Cundinamarca...	279,000	563,000	79,693	7.1	37
Magdalena.....	62,000	150,000	26,950	5.5	27
Panamá.....	120,000	285,000	31,892	8.9	27
Santander.....	306,000	546,000	16,293	33.5	48
Tolima.....	183,000	306,000	18,417	16.5	56
Territories	.....	80,000	24,402	3.2	..
Totals.....	1,931,000	4,00,0000	513,917	7.8	36

Colombia. There has been no general census lately, but at the rate of increase indicated by the table the population must now ap-

COMUN BRIDGE.

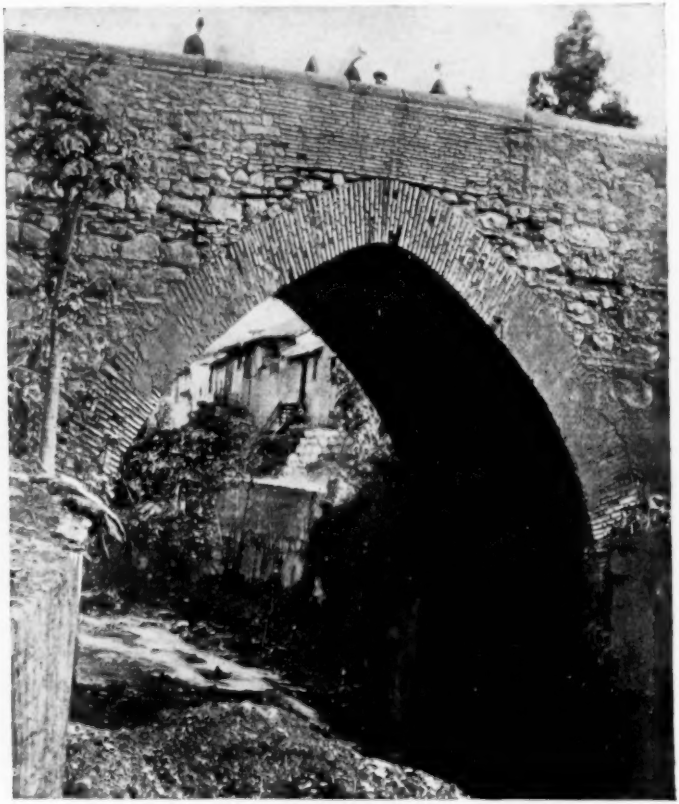
proach very nearly to 5,000,000. To one familiar with the natural growth of the human race as a whole, these figures speak well for Colombia, when we consider that the factor of immigration has been inappreciable, the foreigners settling in that country during all this period not exceeding a few hundred. Indeed, the United States probably would not have made better showing had immigration been stopped fifty years ago. At present not more than 100,000 square miles of the total area of Colombia are inhabited, which would give an average of about fifty souls per square mile; while taking the country as a whole we find only eight to the mile. There is no question as to the possibility of sheltering comfortably as dense a population as that of Europe, which would give Colombia 42,000,000 people. The same average density as the United States would give a population of 10,000,000.

There are yet some 200,000 savage Indians in the country, but these give little trouble. The rest of the population is made up of whites of the Latin race, Indians, negroes, and mixtures of all of these. The whites and civilized Indians are generally found in the mountains, at elevations of from 3000 to 9000 feet; while the negroes—who were freed from slavery long before those of the United States—prefer the lower valleys and the coast. As it makes a material difference to a foreigner as to what department he may locate in, it may be well to study the distribution of the people throughout the country. In Antioquia, an exceedingly



COLON BRIDGE, BOGOTÁ, COLOMBIA.

mountainous region, healthy, rich in mines, and rather sterile as to the soil, the inhabitants are almost all white, with unmistakable traces of Hebraic blood. They are considered by representative travelers as among the most energetic and enterprising people of the country. Some negroes and few Indians are found, but foreigners are rare. In Bolivar the whites also predominate, but there is a good percentage of negroes and mixed people. In this department are situated the main Atlantic ports, in which exists a small colony of foreign merchants. The land is fertile, low, and flat, but the climate is warm and generally unhealthy for new-



SAN FRANCISCO BRIDGE, BOGOTÁ.

BRIDGE OVER THE MAGDALENA AT GIRARDOT.

comers. Boyacá has a large majority of pure and mixed natives, living in the high, healthy, and fertile plateaus of the eastern Cordillera. They are considered good and obedient soldiers. Cauca

GIRARDOT STATION ON THE GIRARDOT RAILROAD.

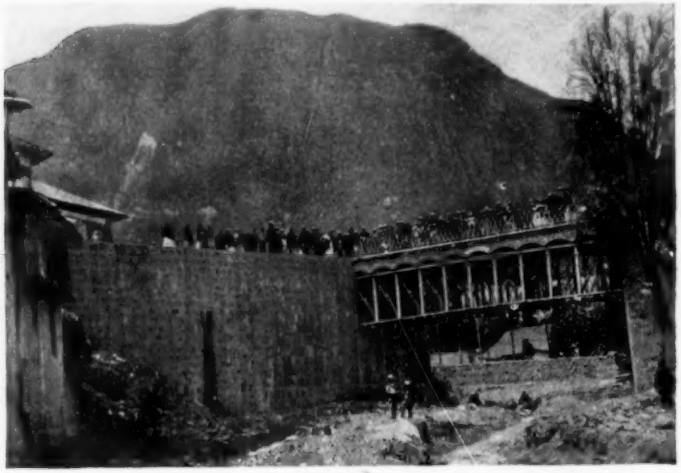
shows a large number of whites, with many pure negroes in the Cauca valley and Indians in the south and southwest. The land here is the most promising to be found in the republic, and within the immense territory of the department are to be found all the varieties of climate in the world. Cundinamarca is like Boyacá in almost all respects. Here we find the city of Bogotá, the capital of the republic, and the most cultured and populous center. Magdalena has undoubtedly the most energetic Indians in the whole country—the "Goagirans." In other respects the department is similar to Bolivar, and the Sierra Nevada region is a healthy and promising one. In Panamá the negroes, Indians, and mixtures predominate. There are quite a number of foreigners, especially merchants. The land produces almost everything, but the climate is generally unhealthy. The inhabitants of Santander are among the most enterprising of the country, and there is not a very large percentage of mixed people. Foreign merchants, and especially the Germans, are prospering here. Its coffee industry takes first place in Colombia. Tolima is the newest of the departments, and is being rapidly populated by Antioquians in the northern mining region. There is no doubt of the bright future for this section, rich in mineral and agricultural products.

Although the upper classes are not as cultured in some respects as Europeans in similar circumstances, they are considered by unprejudiced travelers as well-educated and well-mannered, intelli-

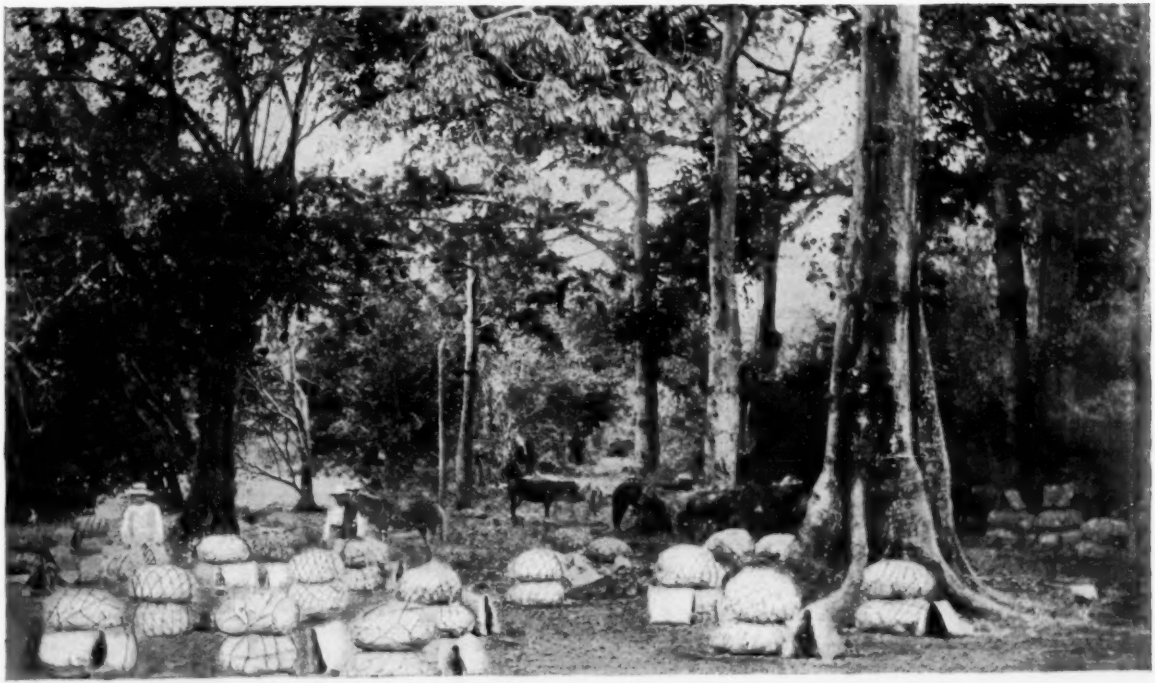
MARKET DAY IN THE CITY OF LA MESA, COLOMBIA.

gent, anxious for progress and enlightenment, patriotic, hospitable, festive, and very sensitive. To be sure, they do not display the enterprise in business that is so characteristic of the people of the temperate zones, and more especially of the Saxon races. That ambition for the accumulation of dollars and the consequent uneasy and restless kind of life of the average business man of the United States is not a quality of Colombians. Nevertheless, under the circumstances in which the country was born and is growing, little more could be expected than what has been accomplished. In the colonial times, by force and by nature, we were obliged to live in the darkness; under our free government, the unhappy political struggles and personal ambitions have been no less a barrier to our progress. Besides, the nature of the country is such as to keep us isolated from the rest of the world far away in the interior of a country of difficult access. The lower classes of the people, especially those living in the mountains, are characteristic for their simple habits, probity, and hospitality, and are not lacking in industrial abilities and habits. In the low valleys and the coast, where the negroes abound, the people are more or less indolent, and even the Europeans who settle in those regions lose a great deal of their energy under our climate.

In fashions and ideas the people are more inclined to follow



SANTANDER BRIDGE, BOGOTÁ, AND MONSERRATE MOUNTAIN.



SEIBA TREES AT JUNTAS DE APALO—MULES RESTING—COCOA PACKS.

HOTEL AT COMUN BRIDGE.

France than any other country ; but there is no prejudice against other nationalities, and all those who care to try their fortunes in Colombia are equally welcomed and respected, provided they do not mix in low politics, while under the flag of their fatherland. If there is found some prejudice in certain quarters, it must be attributed to this cause or to the swindlers and adventurers of all sorts who happen to take advantage of the simplicity of the people. It is hoped that the uninterrupted peace enjoyed since 1886, when the centralized form of republican government was established, will continue.

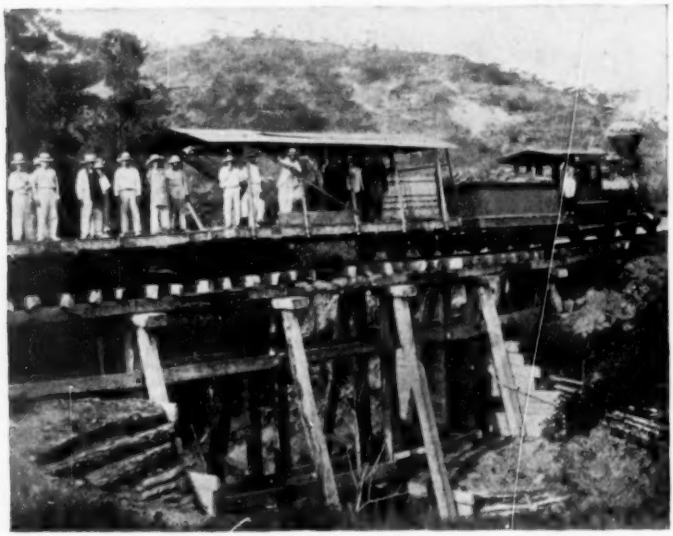
The question will naturally arise as to what lines of enterprise would benefit foreign investors, what channels of commerce are more promising, and what is it that these people need more from without. In answer I will give some suggestions, for whatever merit they may have, as expressing the sentiments of many Colombians, as I understand them.

The great drawback to present advancement, and the one most keenly felt by all classes of people, is the lack of a system of railways. As there is not money in the country for these costly improvements, efforts have been made, time and again, to interest foreign syndicates, but as yet little has been accomplished, in spite of many "concessions," some of which have been ruinous for the country. Railways have been projected, contracts made, work begun here and there and then suspended, all in a more or less reckless fashion, injuring not only those immediately interested,

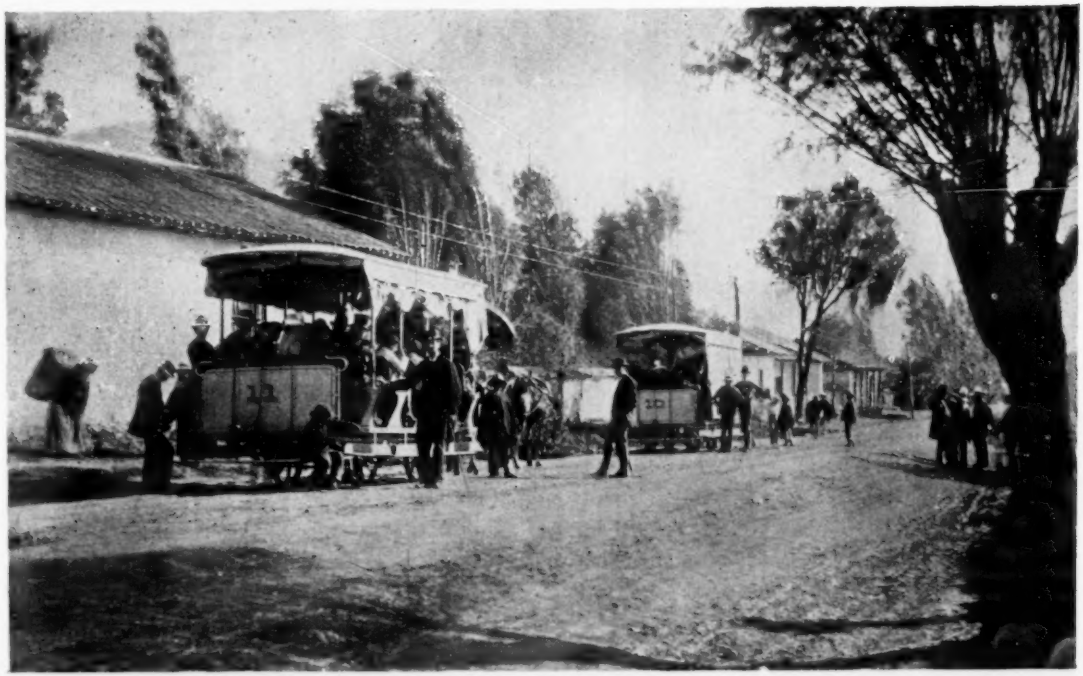
A FARM-HOUSE IN COLOMBIA.

but the cause of railways in general. Had a more conscientious study been made of the lines most needed, and more earnest and persevering work carried out to surmount the great natural obstacles, Bogotá, Medellin, Cali, and Bucaramanga might be to day in rapid communication with the civilized world. As it is, most of these centers are *farther away from our own ports* than is Honolulu from New York. It may not be amiss to give here a short sketch of the Colombian railroads and the regions traversed. The map accompanying this paper is referred to.

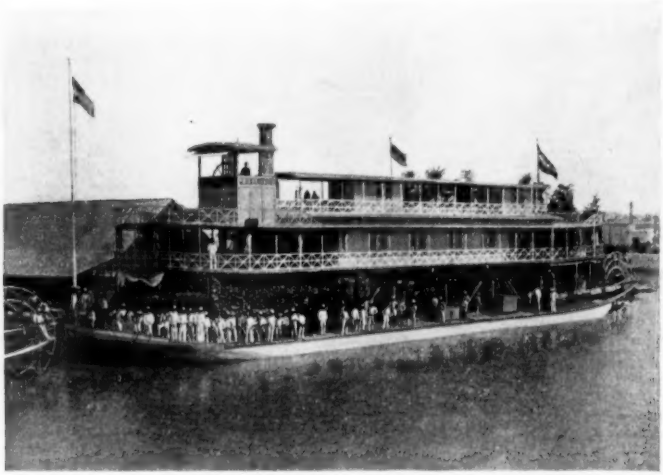
I. THE PANAMÁ RAILROAD.—A concession was granted in 1850 to New York capitalists and the road was completed in 1855, the length being 47.5 miles, from Colon to Panamá, at a cost of $7,500,000. In 1887 the stock was sold to the Panamá Canal Company. This road is complete in itself, and the best equipped in the country. It pays high dividends, but charges unreasonable tariffs. It is not likely that more roads across the isthmus will be needed in the near future; and one for local traffic along its entire length of 400 miles would prove a failure now. Such a railway would be, however, a link in the proposed Pan-American road. The entire northern coast of Panamá is warm, damp, unhealthy, very rainy,



A TRAIN ON THE GIRARDOT RAILROAD.



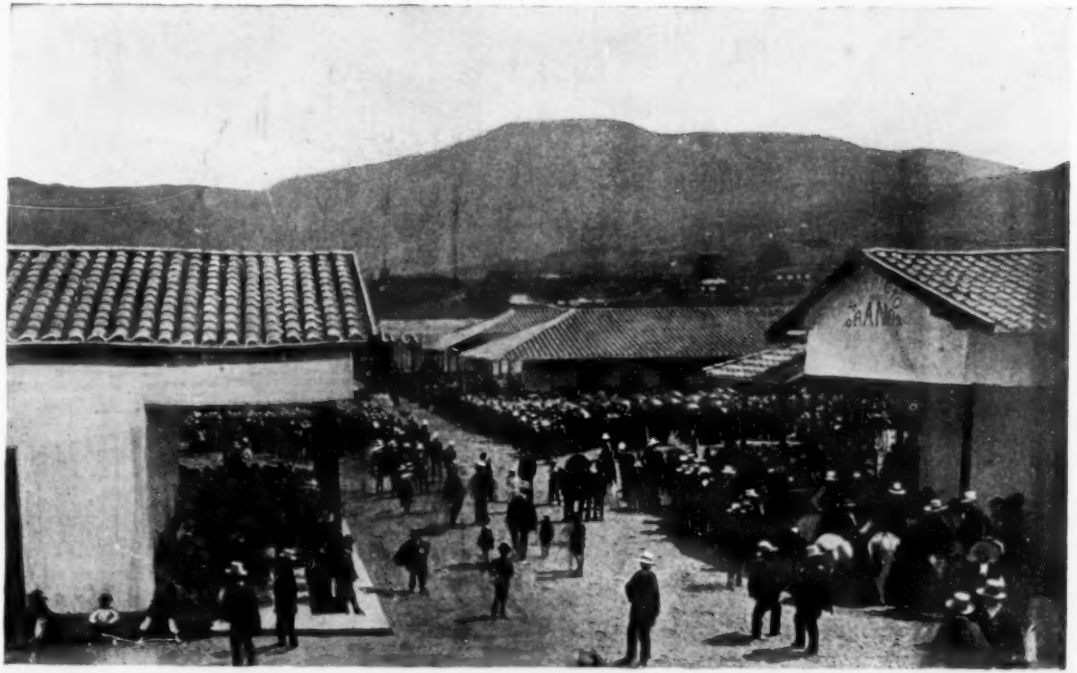
CHAPINERO, NEAR BOGOTÁ, COLOMBIA.



STEAMBOAT ON THE MAGDALENA RIVER.

and almost uninhabited, except by Indians. The mountains back of it, rising a few hundred feet, are wooded, fertile, colder, and much healthier. As yet they are also wild. The San Blas district has some 30,000 Indians, with an export trade of $150,000, especially in cocoanuts of excellent quality. The opening of the hills in this and other districts along the same coast for plantations of cocoanuts, cacao, bananas, and coffee, and the raising of cattle, is inviting. Cabinet woods are abundant. Easy landings are numerous. Already some colonies are prospering. The Pacific coast, from Panamá to Costa Rica, is warm, but generally healthy, the country being free from lagoons and marshes. The hillsides are cereal- and fruit-bearing, cultivated, and well watered. This is the most densely-populated portion of the isthmus. South of the city of Panamá the coast is unhealthy, the mountains unknown, and soon that dreadful and wild region of Darien and lower Atrato valley is reached. This is reported to be rich in mines of gold, platinum, etc.; but with its nine months of rain and terrible thunder-storms, its poisonous creatures of all sorts, the few settlements, and wild Indians, it cannot be inviting for northern people.

II. THE BOLIVAR RAILROAD.—This was contracted for in 1867 by Colombians, and completed in 1870 by a German syndicate. It



MARKET-PLACE IN MEDELLÍN, COLOMBIA.

was bought in 1875 by the government for $600,000 and sold again to a Colombian company in 1884 for $684,000. It connects Barranquilla, on a narrow arm of the Magdalena, with the harbor of Savanilla, at a point called Puerto Colombia, 16.8 miles distant. It is a 3′-6″-gage road, in fairly good condition, transporting the greater part of the trade of Colombia at reasonable rates.

III. THE CARTAGENA RAILROAD.—Projected since 1865, and intended to connect the harbor of Cartagena with the Magdalena river, it is only within the last three years that the actual work of construction has been in progress, under the auspices of the Cartagena Terminal and Improvement Company of the United States. It is reported as nearing completion, with its terminal at Calamar, about 50 miles distant, on the banks of the Magdalena.

IV. THE SANTA MARTA RAILROAD.—June, 1881, was the date of the first contract for this line, to connect the harbor of Santa Marta with the Magdalena river. It is now in the hands of an English company, and has been completed for some 30 miles from Santa Marta towards Peñon (106 miles) or Banco, a town of some importance on the right bank of the river, and about 220 miles from Santa Marta.

Each of the last three lines has the same general object,—to connect the coast with our great interior water-way. Which one will

A STREET IN BOGOTÁ, COLOMBIA.

SANTANDER PARK.

RURAL SCENE IN COLOMBIA.

have the most success of course is impossible to say. The Bolivar road is the shortest, already in operation, and has connection with Barranquilla, 30,000 inhabitants with large commercial establishments, machine-shops for the steamboat companies plying the river, etc. But the harbor of Savanilla is not always safe, being open at the west and southwest, and so shallow that regular ocean steamers cannot yet reach the pier in process of construction, although it is several hundred feet in length. The Cartagena road has to compete with the navigation of the Dique canal, which is, however, very unsatisfactory and uncertain. Otherwise, the harbor of Cartagena is one of the best on that coast of South America, and needs only some $1,500,000 in improvements to make it first-class. The city has 10,000 inhabitants, is comparatively healthy, and its trade has already largely increased. The terminal point on the river is a town of little importance. The third line has also a good harbor at Santa Marta, with deep water and generally safe. The city, with 5000 inhabitants, has seen better times, however, and few vessels touch there now. The railroad would be longer than the others, but crossing a country of superior resources. It will stretch along the western foothills of the Sierra Nevada, an isolated mountain over 17,000 feet high. Going from the foot of it to the top, a person would experience all the climates of the world, from the equator to the poles. The same thing is true as regards agricultural possibilities.

SCENE IN CARTAGENA, COLOMBIA.

The region is very little protected yet and, one might say, almost wholly in possession of savages, some of them hostile. The valleys of the rivers Sevilla, Frio, Cataca, César, etc., are known to have produced gold, from placer and vein mines. Copper was also mined, and the deposits of Camperricho are remarkable for the abundance of mineral, purity of the copper, and good percentage of silver. But the coal deposits probably deserve more attention, as they would supply ocean steamers, the boats on the rivers, and the railroads around there. Good coal has been found on both the eastern and western slopes of the mountain. The Cerrejon district, on the east side, is about the most promising, being only 50 miles from the Atlantic, or the gulf of Venezuela. A coal basin of more than sixty square miles has been prospected and a 70 foot coal measure discovered, composed of ten alternating seams of sandstone and coal. On the line of the railroad, on the river Calata, a 3-foot seam has also been discovered. These coal fields are probably cretaceous. According to Karsten, massive crystalline rocks (amphibole granites, fine grained syenites, etc.), and schists, compose the great bulk of the Sierra, with cretaceous strata, partially metamorphosed, leaning against the Eastern and Southern slopes. The value of these mines cannot be overestimated. We are now importers of coal. In 1891–92 we imported from the United States alone 1400 tons of anthracite and 24,552 tons of bituminous coal. In conclusion, the departments of Bolivar and Magdalena possess excellent lands for plantations of cocoanuts, bananas, cacao, coffee, sugar-cane, and tobacco ; the forests are full of valuable products, and the Sierra region is also promising for mining. The completion and extension of these railroads and the introduction of desirable immigrants, under intelligent management and sufficient capital, would transform these rich lands into prosperous cities.

V. The Dorada Railroad.—The navigation of the Magdalena river is interrupted by two important points,—at the mouth, on the Atlantic, where a bar of dangerous character would require millions of dollars to make the entrance of ocean ships safe, and up the river, some 610 miles, by dangerous rapids at Honda. To obviate the last obstacle the Dorado railroad was constructed, from the said point (at Arrancaplumas) to Veguas, north of it a distance of thirteen miles. The first contract was made in 1879, but the road was only completed in 1884, and since 1887 has belonged to an English company. Lately there have been negotiations and some concessions for the extension of this line seven miles north

of Yeguas, to a better port, and twenty-two miles south of Honda, to the port of Cambao, in communication with Bogotá by a wagon-road; also, from Cambao to the plains of Bogotá, and some projects to join Honda with Girardot by way of Guayabal, Santa Aña, Frias, and Tbagué, following the foot-hills of the Central Cordillera. This northern region of Tolima is important for its abundant mines and agricultural products. Good placers have been found and are in successful operation, some of them using hydraulic giants. Gold-quartz mining has taken much impetus lately, and rich silver mines are in successful working, as the Frias, where, with a jigging plant of modern style, some 80,000 ounces of silver have been obtained monthly—in recent times. Foreigners are largely interested in this region.* The tobacco industry is prospering, and the Ambalema product is well known abroad. Good lands for coffee and sugar-cane are abundant, and the climate in the slopes of the Cordilleras is delightful.

VI. THE GIRARDOT RAILROAD.—There is steamer connection between Honda and the port of Girardot, 90 miles up the river. Hence, a line from this place to the plateau of Bogotá would give an easy access to Colombia's capital from the Atlantic by a route 830 miles long, from Savanilla. The government has been much interested in the project for the last twelve years, but so far only twenty-five miles have been constructed,—from Girardot to Apulo. The work is now in the hands of an English syndicate and is being pushed with vigor. Engineering difficulties are numerous, ascending from 1080 feet of altitude to 8674, within ninety-three miles

VII. THE SABANA RAILROAD.—The high plateaus of Bogotá and

* Accounts of the Tolima mining districts may be consulted in articles by Sr. F. P. Gamba, in "Anales de Tregemeria" (Bogotá), Vols. I, IV, and V. Also in the "Transactions of the American Institute of Mining Engineers," Vol. XVIII, p. 205—Mr. J. C. F. Randolph's "Notes on the Republic of Colombia." Although I have a great respect for so high an authority as Mr. Randolph, I take the liberty to qualify as somewhat exaggerated his statement as to the outlook for mining in Colombia. He says: "The Republic of Colombia does not offer an attractive, profitable, or safe field for foreign investments, and statements as to rich mines in that country should be received with more than ordinary caution." Not having space to give my reasons at length, I would simply remark that we were unfortunate in not having Mr. Randolph remain with us for a longer time and visit many other important mining districts of the country. There are now a good number of Colombian and foreign companies, fairly well organized and equipped, making money, in spite of the difficulties of pioneers. However, investors hoping for rich "bonanzas" and piles of gold, as in early California mining, may certainly keep away from the country. We have numerous and rich mines, but they require intelligent and scientific working, under most judicious management. We have been pursuing either of these two extremes; very primitive and wasteful methods, or extravagant plants, put up by men without practice and knowledge of the country, and designed by an engineer who, perhaps, does not even know where the country is. A medium between the two would be, undoubtedly, more desirable and safer.

RAFAEL NUNEZ,
President of Colombia.

DR. MIGUEL ANTONIO CARO,
Vice-president of Colombia.

Ubaté—probably formerly occupied by Quaternary lakes—embrace an area of more than 1500 square miles and 500,000 inhabitants. On the southern end, at the foot of the eastern Cordillera, lies Bogotá, a city of some 120,000 inhabitants, with most of the comforts of modern civilization. Twenty-five miles in a northwesterly direction, in the highway to Honda, near the point where the abrupt descent to the Magdalena begins, is found Facatativa, with 12,000 inhabitants. Between the two points the Sabana railroad was completed in 1889 by a Colombian company, employing Colombian engineers exclusively. The department of Cundinamarca has been in connection with the enterprise in some way since its initiation in 1881. Some extensions have been considered to points favorable for the junction with the lines in construction from the river. The road is in good condition, with regular service, and paying dividends.

VIII. THE DEL NORTE RAILROAD.—For more than twenty years there have been projects, surveys, and concessions for this line, as a whole or in portions, and following different routes. At present two divisions are in actual process of construction,—at the two ends and under different companies. When connected, however, they

will form with their branches into important points in Santander, Boyacá, and Cundinamarca, the great natural northern route east of the Magdalena river, leaving the Girardot railroad as a link in the great western route to the Pacific ocean, but of little importance for the Atlantic trade with Bogotá. Of course the ultimate desire is to connect the Magdalena and the Del Norte lines, and studies have been made to this effect. The divisions in construction are : (*a*) the Cipaquirá, from Bogotá to the city of the first name, with 15,000 inhabitants, where large rock salt deposits are mined. The distance is 31 miles, and a few have already been constructed under the auspices of a Colombian company ; (*b*) the Santander railroad, 70 miles long, from Puerto Witches to the city of Bucaramanga, a commercial center with 20,000 inhabitants. This is being pushed ahead by an English company. Now, one of the lines advocated to join Bucaramanga and Cipaquirá is about 220 miles long, traversing a mountainous country, but of unlimited natural resources, very healthy, populated by an industrious people, and with some cities of importance, as Chiquimquirá, San Gil, Piedecuerta, etc. Coffee, sugar-cane, and other commodities could be produced of excellent quality in the lower lands, and wheat and potatoes, much needed in the country, could be made articles of exportation instead of importation, as is the case at present in Colombia. The raising of sheep in the high lands and the establishment of woolen factories is inviting. There is something of this now, and it only needs encouragement and facilities for transportation to give employment to a large number of people of the lower classes living in those mountains. Cotton lands are also abundant, and the erection of cotton mills for the manufacture of ordinary cloth deserves attention. The three departments of Boyacá, Santander, and Cundinamarca are likely to become the most important manufacturing sections in the country on account of the abundance of labor and the nature of the people and the country. Coal is abundant at many places, and iron is not scarce. The deposits of Samacá, Pacho, and La Pradera are well known. Of these, the most important at present are those at La Pradera, near Bogotá. A Colombian company, aided by the government, has erected in the last twelve years a large blast furnace and foundry-works, now in successful operation. The extent and possibilities of the enterprise may be judged from the fact that 70 tons of castings are turned out daily.

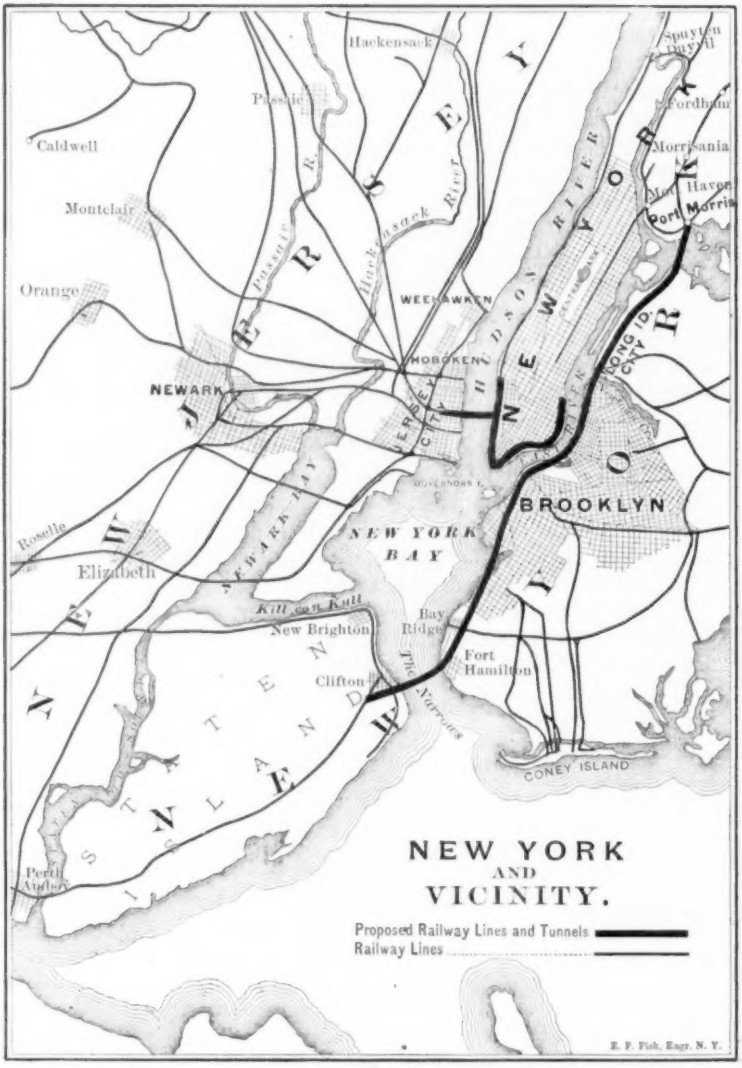
IX. The Cúcuta Railroad.—To connect Villamizar, a port on the river Zulia, with Cúcuta, a rich agricultural center,—and to-

day the most active city of Santander,—a railroad was initiated in 1877 by a Colombian engineer, a national company was formed,—the city of Cúcuta representing one-third of the stock,—and the road was completed in 1888. Although only 34 miles long, it is of great importance for that section of the country, and has been an important factor in the development of the coffee industry, especially. Projects for the extension of this line to Pamplona and Bucaramanza on the one side and Ocaña and Puerto Nacional on the other have been in consideration several times. Lately a concession was granted to Colombians for the Ocaña-Puerto Nacional road, but I understand that it has changed hands, with as yet nothing important done. This section is attractive for plantations of all sorts ; the people are vigorous and enterprising.

X. The ANTIOQUIA RAILROAD.—At a distance of 125 miles from Puerto Berrio, on the Magdalena river, and in the heart of the central Cordillera, lies Medellin, with 45,000 inhabitants, the second city of Colombia, noted abroad for the substantial character of its commerce. Several efforts have been made within the past nineteen years to connect the two places by rail, with an expenditure of over $2,000,000 (Colombian coin) by the department, giving, however, only 29 1-5 miles as the actual result. Last year the departmental government obtained a loan in England and made a contract with the lenders for the construction of the road, and work is now going on enthusiastically. The road is now out of the swamps of the Magdalena, but is beginning to enter into a rough mountainous section. Once in the Porce valley, the difficulties will be greatly diminished, and the success of the enterprise practically assured.

XI. THE CAUCA RAILROAD.—From Buenaventura, our main port on the Pacific ocean, a line was projected as early as 1875, to the city of Cali, distant about 75 miles, and situated in the rich and beautiful Cauca valley. In 1878 the first rails were placed, and in 1882 the section from Buenaventura to San Cipriano, a distance of 16 miles, was ready for traffic, although in a poor and provisional way. Several other attempts have been made to finish the road and prolong it to the city of Manizalez (133 miles), near the border between Antioquia and Cauca, but little has been accomplished. At present a company formed in the United States is pushing this work, and an early completion is hoped for, at least as far as Cali, a commercial center in the department of Cauca.

The importance to Antioquia and Cauca of the completion of their respective roads to the ports of supply cannot be overestimated. If to these we add a railroad connection by way of Cartago and Amaza, following the Cauca valley as far as the creek Sinifaná, between the two important cities, Medellin and Cali, the commerce between the two departments could be largely increased, opening at the same time some of the most magnificent and promising regions for colonization and enterprises of all sorts. Sugar-cane, bananas, cacao, cocoanuts, etc., are produced in the Cauca valley as in very few spots in the world. The hillsides of the eastern and western Cordillera could supply coffee for millions of people, and the mines of Antioquia could give employment to a great portion of the surplus capital of North America. Even now, with mining generally in a crude way, the production of gold and silver is considerable; and the other metals are abundant, as well as coal of good quality. With the establishment of better transportation facilities, there will be undoubtedly a demand for engineers of every kind, mechanics, and experts in manufacturing; also for men with capital and good judgment to develop coffee-plantations, sugar-cane factories, etc. There is not now much need for laborers, clerks, or, in general, men without money, brains, or enterprise, but immigrants with these requisites, anxious to improve themselves and the country, are very much desired, provided they have not in mind the exploiting of the country through building up monopolies and curbing competition.


Hackensack
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Morrisania
Caldwell
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NEW JERSEY
NEW YORK
HUDSON RIVER
Port Morris
WEEHAWKEN
HOBOKEN
NEWARK
JERSEY CITY
LONG ID. CITY
BROOKLYN
NEW YORK BAY
Roselle
Elizabeth
NEWARK BAY
Kill van Kull
New Brighton
Bay Ridge
Fort Hamilton
Clifton
The Narrows
CONEY ISLAND
STATEN ISLAND
Perth Amboy
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Proposed Railway Lines and Tunnels
Railway Lines
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RAILWAY TERMINALS AND NEW YORK HARBOR.

By William Nelson Black.

IT may be safely said that no harbor of either ancient or modern times was purely a work of structural skill, and represented the ideal of engineering science or invention. Harbors grow into being; and they are more definitely fashioned on the lines of certain physical features by which they were originally distinguished than a result of any deliberate plan.

Take the harbor of Buffalo, at the foot of Lake Erie, as an example. Here is a work that may be called almost exclusively a product of civil engineering. Not even excepting the Black Rock section, formed at the head waters of the Niagara river by the stone pier parallel with the shore which enters into the construction of the Erie canal, this harbor is composed exclusively, it may be said, of basins, canals, and channels, some reclaimed from the great inland sea by the erection of sea-walls, some excavated from the solid soil at great labor and cost, and some dredged along the tortuous course of a shallow stream that once formed a fit paddling place for truant urchins who, stripped only to the knees, went in pursuit of tadpoles or other aquatic game. Yet it has grown into a harbor expansive enough and deep enough to shelter many hundred vessels of a class that would form no mean examples of marine architecture in any port of the world. It has now become one of the chief harbors of the continent, the product of a total expenditure of many millions of dollars. But the basis of Buffalo harbor was only Buffalo creek, and it still owes its chief features to that now apparently vanished stream.

While holding, however, that harbors and terminal works in the vicinity of harbors are largely a product of physical evolution, and are often such as circumstances and necessity dictate rather than a conception of engineering science, the writer would not like to be misunderstood. He does not wish to say that engineering science and invention will have less to do with results than natural forces. Skill and an ingenious faculty for arrangement must always remain the chief factors in the construction of good

harbors and effective storage and forwarding appliances; and without this skill and adaptability in arrangement the strongest natural forces and the greatest natural advantages will be likely to produce very feeble results. Buffalo has been made an economical and efficient place for receiving and forwarding merchandise only because the skeleton on which the harbor was reared has been so overloaded with new tissue that the original lines are no longer to be traced.

Very different from the harbor of Buffalo both in natural features and development is the harbor of New York. Here is a harbor upon which nature had originally lavished every advantage. It is spacious almost to the extent of an inland sea, containing a surface of not far from fifty square miles of deep, navigable water, and it is perfectly landlocked and easy of access through two main channels leading in almost opposite directions, but both available for either coastwise or foreign traffic. Yet the harbor of New York impresses one as a harbor on which the hand of the civil engineer has never been exercised, and where nature has allied herself with shiftlessness to show that the science of engineering is a useless pretense. The work that is called engineering, on which the city of New York is now engaged, is not fit to be dignified by any such term. It was merely the conception of some political caucus casting about to find a plausible opening for the expenditure of money, and ready to see it in any scheme that looked defensible, however absurd.

What is really needed for the harbor of New York, when we consider it in all its relations, both shipping and terminal? This is a question of even more importance to-day than it would have been in the days when the name of the cluster of houses surrounding the Battery was New Amsterdam, and the first pile for the construction of the first pier had not yet been driven. It is a question of even greater importance now than then, indeed, for, on account of its location on the coast and other natural advantages, New York has become the chief seat of the commerce of the continent, and whatever affects the economy of its shipping operations is felt in the prices of commodities in the remotest parts of the Union. Nearly half the export traffic of the country, and more than half the import traffic, passes through the harbor of New York; and the city, united with the districts tributary to the harbor known collectively as the metropolitan district, has begun to take such a signal lead in manufacturing industry that it may be said

to almost dictate the general cost of merchandise. Any question touching its terminal and shipping arrangements, then, is a national question, or, to use a safer word in these days of congressional usurpation, a continental question, and it should be of universal interest. What do the harbor of New York and the railways concentrating on the harbor need to enable them to meet the demands of the merchants and manufacturers of the metropolitan district in the economical handling of their merchandise and material?

Before attempting to answer this question it will be well to take a hasty look over the field and observe what is most defective in arrangement. At the very first glance we discover that the metropolitan district in its sections most favorable for growth and improvement is mainly insular. Neither one of the three islands that contain nearly all or ninety per cent. of the naturally navigable water front of the district can be reached from the mainland except by structural agencies of either an engineering or nautical description; and we discover, also, that, down nearly to date, nautical agencies only have been brought into service. We see further that some of these agencies are of the most rudimentary character. True, little fault is to be found with the ferries. The boats are generally spacious, often elegant in design and decoration, and move with a frequency and despatch which, considering the directness of their lines of transit, leave little to be desired, if it does not even place them beyond rivalry on every reasonably fair day of the year. But the ferries are agencies only for the transportation of passengers and local freight, and they fail, therefore, of serving the chief needs of a great commercial and industrial center, operating over a field of continental magnitude. It is in the means for handling a long distance freight traffic that New York is most fatally defective; and as we see the ungainly scows that are used upon the harbor for transporting sections of railway trains between widely separated piers, called by courtesy floats, we cannot help wondering at the seeming want of enterprise which has so long rendered such exhibitions possible.

But we must not limit our observation to the harbor alone if we wish to comprehend all the disabilities of New York as a commercial entrepot. The surface where we will see least evidence of any capacity for engineering will be found upon the land. We shall discover it in the street plan of the city of New York itself, in the location of the warehouses, and in the consequent ava-

lanche of trucks that distinguishes the city beyond any other city in the world, and without which it would be impossible to move any part of the large traffic which tradition rather than intelligent policy still enables it to retain. More than 30,000 trucks are needed to carry on the commerce of New York, a number which makes the truck driver the leading industrial worker of the city, almost rivaling the common laborer in his numerical strength, and standing as the representative of more than $25,000,000 of capital in vehicles and horses. But the wasted capital that he represents is not the worst offense that can be laid to his charge. He is insatiable in his demands, and imposes a tax on the commerce of the port approximating $50,000,000 annually.

It will be necessary to revive here a subject introduced a year ago in the pages of this Magazine when the articles entitled "New York's Commercial Blight" were published, and recall what was then said in relation to the political complications that have long involved the water front of Manhattan Island. Through an act of official robbery, dating back about two centuries, New York has inherited a water front system unparalleled elsewhere on the face of the globe, at any geographical point of its surface or at any period of time; and this system has proved to be as injurious as it is unconstitutional and absurd. The municipal ownership of the submerged lands around Manhattan Island, though it was not necessarily productive of all the damaging sequences that have followed, has unquestionably given to the city those broad plazas along the water front which have usurped the ground demanded for storage warehouses, and driven all warehouses, whether storage or wholesale, either to other parts of the metropolitan district or to the interior. Whatever other incidental mischief it may have caused, this piece of Bellamyism was certainly the cause of the exterior streets, and of the plague of trucks which have descended upon the city like an invading force of Kansas grasshoppers.

But now attention must be directed more exclusively to the remedy for these various imperfections. For correcting the insular disabilities of the water front the tunnel or bridge will suggest themselves to the civil engineer, according to his preferences, as the only alternatives; and the financial promoter, though necessarily conceded to be a man of infinite invention when judged by the schemes which he deliberately conceives and sometimes organizes for the benefit of the city, both below and above ground, can hardly be expected to find anything better. He will perforce be compelled

to accept either the tunnel or the bridge; but there is a choice between the two, and it will be well to devote the remainder of this article to a consideration of this phase of the subject. Which will make the best terminal improvement for the metropolitan district, and especially for New York?

The writer may as well confess in the beginning that he is prejudiced in favor of the tunnel. But his prejudices are a result of many years careful study of the subject, and are founded on what he conceives to be good and substantial reasons. Before proceeding to their statement, however, he must be permitted to file a caveat. He has no prepossessions in favor of any of those extravagant tunnel schemes, sometimes advocated and even organized, which propose descending into the bowels of the earth and creating a subterranean city communicating between its parts through many miles of subterranean avenues. The surface of the earth was made for man; and, except for extraordinary occasions, it will be time enough to go under ground when we are buried. But the tunnel, restricted in length to the distance necessary for maintaining communication between points separated by channels, and not made so deep at the terminals as to be difficult of access, seems to lead most directly and economically in the true way,—the only way, indeed, that promises the final removal of perhaps all the water front disabilities that afflict New York.

The advantages of the tunnel are many and various. In the first place but little more than a total length of two miles and a half under water, the only place where the tunnel builder is likely to meet costly obstructions, would be needed to bring all sections of the water front within reach of the trains. Doubtless there would be advantages in having a tunnel for every railway, and it is pretty certain that all the railways will provide themselves with tunnels for their own exclusive use when they find that the metropolitan district will no longer be satisfied with the present disconnected and extravagant service; but in the beginning the completion of the Hudson-river tunnel, already about three-fourths through, and the construction of two similar works for the benefit of the Long Island water front, one under the channel below Bay Ridge, and the other under the East river at the point of its opening out into Flushing Bay and Long Island Sound, will supply all the accommodation needed.* The enterprise of Erastus Wiman in grappling with New Jersey and tying it to Staten Island at Eliza-

* See the map accompanying this paper.

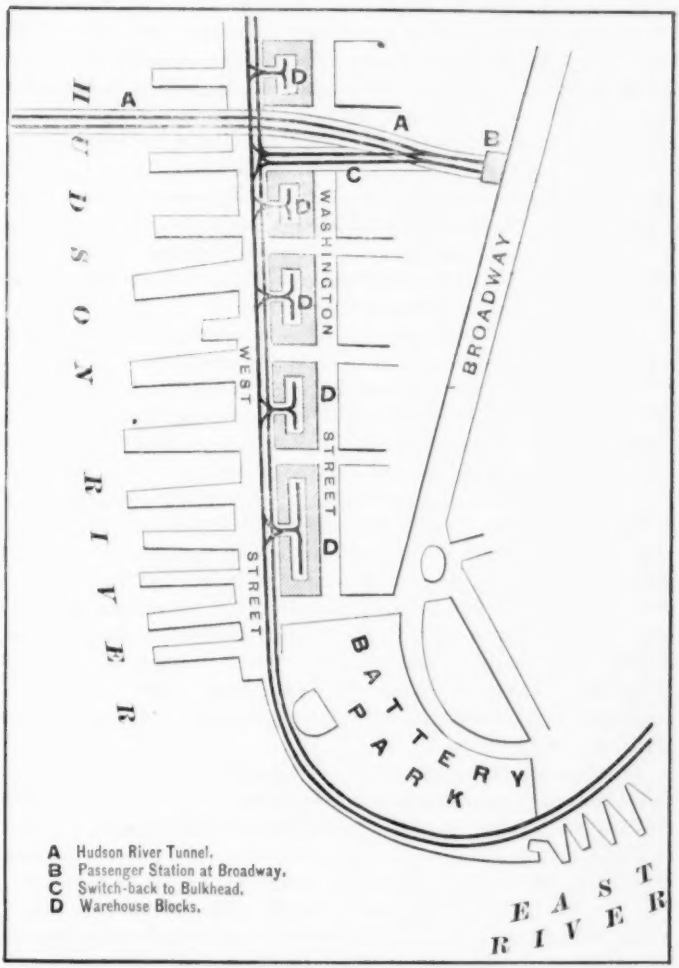
beth has already furnished the link that will render the two last named improvements available; and a water front railway, both surface and elevated, through the warehouse district of Brooklyn and along the entire shore of the East river, will complete a connection that will be of incalculable benefit not only to the traffic of the port but of all New England and the entire Union.

A single glance at the map, and especially at a map large enough to expose the fact that Boston, Brooklyn, Philadelphia, Baltimore, and Washington are almost exactly on an air line, should show the superiority of this system for Long Island. It would be a connecting system in its broader features. It would be terminal only in its relations to the harbor; and it offers to Long Island the only free and unobstructed route to the mainland that can lift it above the condition of vassalage to New York which it has heretofore held. But it is New York itself, after all, that is most in need of enfranchisement; and it will be easy to show why it will derive a greater benefit from tunnels than any of its municipal neighbors. Geographically, the city is a wedge driven into the heart of the metropolitan district; and its lead is threatened only because it is blindly banishing or pusillanimously surrendering its traffic.

We must not for a moment lose sight of the fact that the curse of New York is its inflated truck service. All its warehouses and factories not driven to Brooklyn or Jersey have been scattered throughout the city by the truck service, and it has prevented their concentration along and near the water front where they belong. It is the cause, also, of those filthy, indescribable streets that have led to so much public criticism, and of that general appearance of dilapidation and decay for which many of the sections most available for improvement are conspicuous. It offers, moreover, an explanation of the fact that it often costs more money to handle merchandise in the port of New York than it costs to transport it from New York to Chicago. It is then, of course, the first disability to be removed. But could it be removed by the construction of a bridge across the North river? Would it not rather be extended and made to cover the whole city where now it is concentrated chiefly in certain unhappy districts, and localized?

Observe, first, how quietly the tunnel will come to New York, and how little its operations will disturb the city. Suppose the Hudson-river tunnel to be completed. There will be a passenger station, say at Broadway or wherever the engineers think it can be

most economically and conveniently maintained. But there will be no blockade of trains. The cars will remain invisibly below the surface where only the electric light will penetrate, and as to the freight trains, they will be even less obtrusive than the pas-



SECTION OF LOWER NEW YORK CITY.

Showing proper terminals and warehousing arrangements.

senger trains. When half way up the grade to the passenger station, they may be led quietly back to the bulkhead by a switch-back, as shown in our second diagram, and from thence, on surface railway tracks, they can distribute themselves along the water-front to any part of Manhattan Island. For the receipt or delivery of merchandise, the cars can even enter the areas of all the water front blocks without intruding upon any street or public place in the city. Can anything more convenient be conceived? It should readily be seen that such an arrangement would draw all the heavy traffic of the city irresistibly to the water-front, the wholesale merchants seeking the first blocks from the river, and the manufacturers crowding as closely as possible into the same neighborhood. The arrangement would represent the perfection of forwarding machinery; and all the trucks engaged in anything but local service, a very limited service, would disappear from the streets.

But over against this picture, which is truthfully drawn, place a bridge across the Hudson, and observe the difference. In the very heart of New York, which would offer about the nearest point where such a flying structure could reach the ground, we see a huge freight station where all the traffic of the city, including possibly its coal traffic, would be expected to concentrate. But the warehouses and factories, where are they? Dispersed everywhere, as now, but, still more broadly dispersed, they would only create the necessity for longer truck hauls and more trucks. The immediate vicinity of the station would offer a surface too restricted for more than a small part of the total traffic, and no attempt at concentration would be made. Manhattan Island would soon become a place unfit for residence. Yet just those districts of the city which are suitable for commercial operations would still remain neglected, and be tenanted only for the filthiest traffic purposes as they are to-day.

On the side of economy, too, the argument is altogether in favor of the tunnel. An actual expenditure of little more than $20,000,000 would place every inch of the water front in the metropolitan district in direct connection with the railways. The interest on this sum, to be drawn from the traffic, would be $1,200,000 annually. But the cost of a bridge which would serve Manhattan Island alone, when estimated with the cost of material, labor, property purchased, and damages combined, would not be less than $100,000,000, a cost that would demand an annual payment of $6,000,000

in interest. The traffic would not meet such a charge without bearing a much heavier tax than is imposed by the float and ferry service, which, though costing a great deal, does not cost more than the interest on $35,000,000. Under the operations of a bridge service, too, another $50,000,000 annually would soon have to go to the support of truckmen.

These are the chief reasons for preferring the tunnel to the bridge. They could be strengthened greatly by amplification, and there are still other reasons of minor weight that might be thrown into the balance. It could be said, for example, that the suspension bridge, which is an inverted arch in form, is an unsuitable object for urban decoration, and that the cantilever bridge is still more objectionable from the esthetic point of view. But the arguments drawn from economy and the necessity of relieving the streets of New York are so heavily on the side of the tunnel that any further reasoning in its behalf seems like a waste of time.

LABOR LEGISLATION IN ENGLAND.

By R. S. Viktorov.

"LABOR legislation" is notoriously a perpetual topic of all contemporary law-making bodies. Everywhere labor loudly demands "protection" against the encroachments of the employers; and politicians, making a virtue of necessity, grant more and more of the demands. A bold minority of the workmen go to the length of agitating for the total suppression of private, competitive enterprise and the assumption of all industrial functions by the State. Few practical and active men of affairs sympathize with this utterly impracticable revolutionary plan, but there is as yet scarcely any recognition of the fact that the same vicious principle underlies most of the less radical proposals advanced in the interests of "labor," and hence even among business men of experience the opposition to paternal legislation is but feeble. In truth, labor's implicit trust in legislation is no anomaly. Most of us are addicted to the habit of appealing to government for aid and salvation. The feeling is widespread that "the law" can and should eliminate all existing evils and rectify all surviving wrongs. It is to politicians that manufacturers look for profits, farmers for low interest and high prices, workmen for good wages and short hours. This universal faith in the efficacy of legislation persists in spite of overwhelming adverse evidence. The absolute failure of one law does not prevent us from clamoring for another of the same kind; the mischief following one legislative excursion into the business sphere does not serve as a warning against inviting another.

Look at recent federal legislation in the "people's interest" in the United States. The present financial crisis is generally attributed to the Sherman silver law,—a law that was passed to secure the benefits of an abundant currency. Will the pernicious consequences of this act teach the lesson of less government-tampering with currency and more financial freedom? Hardly. Or take the tariff. Whether we are theoretically protectionists or free-traders, the absurdity of a large class of business men anxiously watching every move of a lot of politicians in Congress must be manifest to all. Frequent changes breed confusion, un-

certainty, distrust, while business requires stability and confidence above all things. As long, however, as the tariff remains "in politics," no permanent condition is possible. The interstate commerce law is another abortive effort to check certain objectionable practices that competition alone is competent to deal with. The "protective" features of the law are successfully evaded, while new evils are called into being by it that are offset by no advantage whatever. And where are the great results of that other popular measure, the anti-trust law? The few attempts at its enforcement have only furnished amusement and political capital.

The important consideration is that every restriction tends to cripple industry and hurt both employers and employed. Blind interference with the laws of industrial development, attempts to accomplish results which in the nature of things cannot be arbitrarily and summarily accomplished, retard the increase of wealth and the spontaneous adjustment of the relations between the coöperating forces in production. Industry needs freedom, opportunity. Business men need to learn the lesson that industrial freedom is the first condition of prosperity and stability, and that politics is fatal to business.

The whole history of English labor legislation—the parent of all paternal and socialist proposals—enforces the truth that the true interests of labor cannot be promoted by political measures. The record is one of failures, abortions, farcical results, and disappointments. No proper history of the rise and growth of the factory system and the concomitant legislation has yet been written, but the facts afforded by the historians of this system are instructive enough to be reviewed here.

The first English factory (in the modern sense) was the celebrated silk "throwing mill" erected in Derbyshire, in 1719, by Sir Thomas Lombe. It is certain, however, that factories of a primitive kind were in existence before that date. In 1340 one of the chief promoters of cloth making in Bristol was ordered by a local court to pay a fine "for having caused various machines for weaving and making woollen cloths to be set up in his houses, and for having hired weavers and other workmen for this purpose." Lombe's patent for the machinery expired in 1732, and the "industrial revolution" was started upon its way. In 1832 the change in industrial method had spread so wonderfully that we find parliament and the country debating the first comprehensive scheme of legislation devised to modify some of the results of the new system.

There was violent opposition to the early factories on the part of the working people, and the popular literature of the day gives expression to the feelings of the dissatisfied operators. "When the first factories were erected," says "Alfred," the historian of the factory movement from 1802 to 1847, "it was soon discovered that there was in the minds of the parents a strong repugnance to the employment thus provided for their children," and "for a long period it was by the working people themselves considered to be disgraceful for any father who allowed his child to enter the factory." As early as 1779 a spinning mill of Arkwright's was wrecked. Somewhat later Peel's printing works were gutted and the machinery destroyed. When the first steam-engine for spinning was erected by Mr. Hall, he was obliged to convert his mill into a garrison and keep the gates locked both by day and night. These are samples of what occurred in Lancashire, and similar scenes were enacted in Yorkshire and in the Midland counties. Factories were destroyed, manufacturers attacked, and one manufacturer was shot near his own home. As late as 1835 opposition was encountered, when steam was first applied to ribbon-weaving. The interesting fact may be recorded that in the case just mentioned the very remarkable experiment was tried, in the hope of conciliating the workmen and combining the advantages of the factory with those of domestic industry, of having a central engine to supply power to a number of cottages grouped round. The experiment naturally failed.

Froude quotes the curious statute passed in the reign of Philip and Mary which was directed against factories. The statute is called "An Act Touching Weavers," and runs thus: "Forasmuch as the weavers of this realm have . . . complained that the rich and wealthy clothiers do in many ways oppress them, some by setting up and keeping in their houses divers looms, and keeping and maintaining them by journeymen and persons unskilful, to the decay of a great number of artificers which were brought up in the said service of weaving, with their families and their households, some by engrossing of looms into their hands and possession and letting them out at such unreasonable rents as the poor are not able to maintain themselves; . . . some also by giving much less wages and hire for weaving and workmanship than in times past they did, whereby they are enforced utterly to forsake their art and occupation; . . . it is, therefore, for remedy of the premises and for the avoiding of a great number of inconveniences which may grow if in time it be not foreseen, ordained and enacted by author-

ity of this present Parliament that no person using the feat or mystery of cloth-making and dwelling out of a city, borough, market-town or incorporate town, shall keep or retain or have in his or their houses or possession any more than one woollen loom at a time, nor shall by any means, directly or indirectly, receive or take any manner of profit, gain, or commodity, by letting or setting any loom or any house wherein any loom is or shall be used or occupied, which shall be together by him set or let," etc. A provision follows limiting weavers living in towns to two looms. The intention of course was to prevent the cloth manufacture from falling into the hands of large capitalists, and to enable workmen to earn their living in their own separate homes.

It is instructive to recall this pathetic preference for "home work" and bitter opposition to the factory in these days of popular and philanthropic clamor *against* home work. Labor reformers who are so anxious to force all workers into the factories are probably unaware of the attitude of the early factory workers and their champions towards the new arrangements that faced them.

Whether the anti-factories statute was formally repealed or simply disregarded and consigned to oblivion is not stated by the historians. It was never vigorously enforced, though there is no doubt that the legislation which was directed against labor was faithfully carried out. It was not till 1795 that a workman could legally travel in search of employment out of his own parish; it was not until 1812 that the power of the magistrates compulsorily to fix the laborer's wages was withdrawn; and the famous statute of apprentices was not repealed till 1814.

In 1796 the first protest against "unregulated factories" was raised by a committee called the "Manchester Board of Health," which enumerated the evils of the factory system and proposed an application for parliamentary aid to establish a system of laws for the government of cotton factories. By that time the repugnance of the operatives to factory labor had been largely overcome, and some had actually begun to live on the wages of their children. The first bill dealing with the subject of child labor was that prepared by Robert Owen and presented to members of Parliament in 1816. It forbade the employment in factories of children under ten years of age, and limited their hours of work up to eighteen years to 10½ hours a day. It further prohibited them from night work, and provided for half-an-hour's instruction daily at the expense of the employer; it was to apply to all "cotton, woollen, flax,

and other mills, manufactories, and buildings, in which twenty or more persons shall be employed under the age of eighteen years." Sir Robert Peel at first pretended to favor the measure, but subsequently he declined to father it, and introduced, instead, a bill to apply exclusively to cotton mills, which was far less stringent in its provisions. This, however, was not the first factory bill brought before Parliament. Sir Robert Peel had already passed one important measure through that body,—the Factory Health and Morals Act of 1802. This first English factory act applied principally to *apprentices* in cotton mills, and in no wise affected *free labor*. Its principal provisions point to a time when the employers stood in a sort of paternal relation to their apprentices, and indicate that the new industrial system had not yet emerged from that phase when mills were built in unfrequented places and supplied with apprenticed workers from a distance. The apprentices' hours of work were not to exceed twelve a day, and they were to be instructed every day, during the first four years, in reading, writing, and arithmetic, the time to be counted out of their work-hours. They were likewise to be instructed in the principles of the Christian religion, and made to comply with various religious ordinances. Other provisions relate to their food, apparel, and health.

This law, by placing apprentice labor at a disadvantage, constrained the manufacturers to abandon it. They now preferred *free* labor. This effect of the law, coupled with the adoption of a new motor, which, by removing the necessity of building factories in remote and water-abounding districts, and permitting their establishment in populous places, rendered the apprenticeship system unnecessary, was in turn the cause of the next move of the factory reformers. In 1815 Peel proposed a new measure applying to all children alike. What he proposed was that no child should be employed under the age of ten years and that the duration of children's labor should be limited to twelve hours and a half per diem, including the time for education and meals, which would leave ten hours for work proper. In presenting this bill Peel regretfully acknowledged that the inspectors appointed under his previous bill had been very remiss in the performance of their duties. But this bill met with vigorous opposition, and its author was induced to alter the form of his motion into a proposal for a committee of inquiry to ascertain the conditions of child labor and report to Parliament. This proposal was accepted, and a parliamentary inquiry—the first of its kind in English history—was authorized. The committee

commenced its sittings in 1816. Its proceedings and conclusions were alike contemptible. It was in fact a complete fiasco. The value of the testimony taken by it may be judged from the fact that, whereas the average death-rate in England at that time was 1 in 50, it appeared from the "evidence" that in the cotton factories it was 1 in 445! The reformers generally exaggerated the evils of the state, while their opponents indulged in preposterous eulogies of factory labor. On the one hand, medical men and other witnesses spoke of the absolute impossibility of supporting healthy life under the circumstances that existed in the factories, while on the other tabular statements and documents signed by clergymen and magistrates were presented showing the superiority of the health and *morals* of children employed in factories over those of children employed in other trades. One witness, a surgeon, was not sure that the inhaling of dust and cotton fibre was injurious to health, suggesting that the bad effects in this case might be counteracted by "constant expectoration."

The upshot of this "investigation" was a new law, passed in 1819, applying exclusively to cotton mills. It forbade the employment of children up to nine years of age, limited the hours of work for all persons under sixteen to twelve per day, less 1½ for meals, and made some provisions for recovering time lost by defect of water. The law, however, contained no adequate provision for inspection and attendance of witnesses in cases of prosecution, and hence was easily set at nought. Several amendments of the law followed, the last being that passed in 1831, which prohibited night work in the case of persons under twenty one years of age in cotton factories.

Discouraging as these results were to the promoters of factory legislation in parliament, the operatives and the reformers outside of parliament found in them a stimulus to further agitation. Demands were boldly made for a work-day of ten and even eight hours for children. But the government had now determined to take the initiative themselves, and stave off radical legislation by moderate proposals. A motion was made on behalf of the government for the appointment of a royal commission to visit the factory districts and collect information. It was adopted, and the commission was appointed. The operatives and their friends resented the presence of the commissioners in their districts, and protested against the proceedings. They asserted that full evidence on all important points had already been collected, and

that the real object of the government was to procure evidence unfavorable to further legislation. The commission, however, reported in favor of further legislation on behalf of the factory children, and in 1833 the government offered and passed the important bill commonly spoken of as Lord Althorp's Act, which has formed the basis of all subsequent legislation. The act prohibited the employment of children under nine years of age in all mills and factories except those for the manufacture of silk. It was made unlawful to employ children in any mill for a longer time than forty eight hours in one week, or nine hours in any one day. Two whole and eight half-holidays in the year were provided for, as well as daily attendance at school for at least two hours. Surgical certificates of age were required, and factory inspectors were given large powers. No person under eighteen was to be employed at night. Compulsory education was for the first time formally recognized as a function of government.

But scarcely was Lord Althorp's Act in operation when numerous and grievous imperfections in it were indignantly pointed out by the factory reformers. Several of the clauses were so drawn as to be absolutely incomprehensible, and the important item of administration was a total failure. The provisions respecting meal times were insufficient, and a wide margin was allowed in the selection of the working hours of the protected employés. A regular system, known as the Relay System, was at once devised for defeating the intentions of the act. To keep their machines going longer than twelve hours, the manufacturers established relays, which commenced work at different times of the day; and the factory inspectors declared that so long as the employers had the power to work relays, to fix irregular meal hours, and to alter continually, at pleasure, the working time of every individual, no legal restriction of the time of labor could be enforced. The regulations respecting certificates of age did not work well. The expedients for gauging the ages of children applying for work were all unreliable, and parents obtained certificates for immature children by substituting older ones for them. When inspectors visited the works, the doubtful cases were hidden under large baskets or otherwise concealed; or their shoes and clothing were stuffed to make them appear stouter and taller. There were other defects in the law. The time within which an information for an infringement of the law might be laid was only fourteen days. Manufacturers were not prohibited from sitting in judgment on

factory cases. The overworking of any number of children simultaneously by an employer was construed as one offense and punished accordingly. Hence it was more profitable to break the law than to obey it.

Under these circumstances the agitation was renewed, and several unsuccessful attempts were made to amend the bill which had proved so ineffective. In 1840 a resolution was passed providing for a children's employment commission. In 1843 the commission made its report, urgently favoring legislation with reference to certain trades and manufactures. The only result, however, was an act applying to print works, which pleased nobody.

A new factory bill was passed in 1844. This bill embraced precautions against the devices which had defeated the previous measure, and contained some novel and striking features. It was now proposed to extend the protection of the law to adult women, and machinery and mill gearing were to be fenced. The hours of work for children were reduced to six-and-a-half per day, to be taken either in the morning or afternoon. In 1847 the ten hours act was passed, which limited the hours of labor for women and young persons to ten hours a day and fifty-eight a week. But the relay system was again introduced, and it was impossible for the inspectors to enforce the law, especially since the courts had declared the relay system legal. To surmount these difficulties a compromise bill was passed which established a different limit to the working-day,—namely, from six A. M. to six P. M. in summer, and from seven A. M to seven P. M. in winter, with one and a half hours for meals, and till two P. M. on Saturday. This statute brought the ten hours dispute to a close, and remained in force for fourteen years. In 1860 bills were passed regulating bleaching and dyeing industries, and soon afterward legislation was applied to lace work and bakeries.

In 1862 a second children's employment commission came into existence, which "nearly exhausted its subject," and issued numerous reports. The first important result of its labors was the new factory act of 1864, in which the previous legal conception of a factory, as a place where only textile fabrics are produced and mechanical power employed, was formally abandoned. The new act applied to four kinds of manufacture not textile, and to two kinds of "employment." The agreement was that in those particular industries and employments—the manufacture of earthenware, lucifer matches, cartridges, etc., and the employments of

paper staining and fustian cutting—hardships prevailed, and therefore required to be regulated and looked after. Naturally this argument justified interference with numerous other occupations, and in 1867 the factory acts extension bill was passed, whose provisions applied not merely to factories in the old sense, but to any premises in which fifty or more persons were employed in any manual labor incidental to the making of any article. The transformation was almost complete, and it only remained to add places where less than fifty persons were at work to cover every material industry.

And this was actually undertaken within the same year by the Workshop Regulation act. A workshop was defined to mean any place or room in which any handicraft is carried on by any young person, woman, or child under the direction of another. The act differed little from the factory acts. At first the local authorities were charged with the supervision of the workshops ; but their failure to perform the new duties subsequently led to the handing over of the act to the factory inspectors for enforcement.

In 1874 an act was passed which amended the factory laws in certain particulars. Labor in textile factories was reduced by half-an-hour a day, the minimum age for children was raised to ten, and it was made illegal to employ a young person under fourteen who had not passed a certain educational test.

Of course these acts did not close the factory controversy. No sooner had they become law than new agitations sprang up on several new subjects. Shop labor, wandering occupations, even domestic labor, began to clamor for protection. At the same time the laws relating to factories and workshops, and the practices and judicial decisions in regard to the relation between them, had reached an intolerable pitch of confusion. To consider the new claims and reduce the conflicting and contradictory statutes to order a royal commission was appointed in 1875. The commission was to consider the consolidation and amendment of existing laws, and decide whether any of their provisions might be properly extended to other trades and occupations. But the commission disappointed the factory reformers by dealing almost exclusively with the first half of its task. They brought together existing laws into one statute, but recommended no new legislation of consequence. They excited indignation by announcing their purpose to be the relief of minor industries from the pressure of legislation and the securing of more independence to adult labor.

The factory and workshop consolidation act of 1878 which was the outcome of the commission's labors is the one still in force. It deals with five classes of works,—textile factories, non-textile factories, workshops, workshops in which only adults are employed, and domestic workshops. Certain industries—straw-plaiting, pillow-lace making, and glove-making—are left free, and the exemption extends to any handicraft exercised in a dwelling house by a family at irregular intervals. Workshops where men only are employed are, unlike factories, always exempted. A factory, under this act, is a place in which machinery is moved by some mechanical power. The works where manual power is made use of, exclusively, are workshops.

The demand for legislation at present is precisely in those directions which the current law leaves free. The cry is now for regulation of adult labor and for interference with minor industries. Laws are demanded against "sweating," home work being regarded as the citadel of the evils summarized under that term. It is held to be imperatively needful to force all workers into the factories. Strenuous efforts are made to bring all home industries under inspection. Thus Mr. Charles Booth has been giving evidence before the English Labor Commission, and he has been suggesting ways of getting rid of the "sweating evil." A good deal might be done, he thought, by a "sufficiently wide extension of the Factory and Workshops Act." He favored a provision that home workshops should be registered and made subject to inspection and supervision. He would define a workshop as any room or place where any person joined another person in manufacturing, and that *would include a man and his wife*, while two men working in partnership would be considered as employing one another. The industries which would be most affected by this legislation would be tailoring, boot-making, cabinet-making, and upholstery, with seamstresses' work of all kinds. The larger number of persons employed in home workshops are women, but Mr. Booth thought that it would be a desirable thing to see home work superseded by work in factories to a very considerable extent, though not to the extent of driving it out altogether. There were thousands of cases, according to Mr. Booth, in which registration and inspection would at once begin to apply, where the rooms in which two or three persons worked were used also as living rooms and sleeping apartments.

A word may now be said on the subject of the effects of factory

legislation. All the English economists were opposed to the sweeping act of 1844, and warned parliament that its passage would surely cause diminution of production, rise in cost of production, fall in rate of wages and profits, rise in prices, and loss of foreign trade. It is true that hardly any economists of to-day would wish to see that act repealed. The results they feared and expected nowhere came to pass. Instead of dwindling, the English textile industries developed enormously during the years 1850–1863, and English industry flourished during the twenty years immediately succeeding the introduction of the factory acts. But no economist claims that this prosperity is *due* to the factory legislation. On the other hand, there are economists who trace certain evils to the operation of the factory laws. The sweating system has for a chief cause this labor legislation. As one writer says: "On the whole, factory legislation tends to press heavily on the very weakest class of workers. Their last asylum is some hitherto unregulated branch of domestic industry. Such a refuge, for instance, has been the wearing apparel trade." Factory legislation has also injured the weaker elements of the capitalist class, and everything that hurts the small business man hurts the workman. During the decade 1853–63 no less than three hundred cottage factories were shut up. The struggle between the cottage factories and the factory system proper naturally ended in the complete ruin of the smaller works. This concentration of industry was unquestionably accelerated by factory legislation.

The probability is that the improvements in the condition of the operatives would have gradually taken place even if parliament had not interfered at all. It is easy to mistake coincident circumstances for cause and effect, and those who claim that factory legislation has been an unmixed blessing fall into this error.

ARCHITECTURE AT THE WORLD'S FAIR.

By Barr Ferree.

WHATEVER may be the final result of the Fair, however deeply it may impress itself and its lessons upon the people of America, its architectural teachings will be long remembered. At no time in our history has architecture as a fine art so vividly impressed itself upon Americans, and it would almost seem, so great has been the enthusiasm raised by the chief buildings of the Fair, that an architectural renaissance—a revival of the art of building in its truest sense—was about to take place among us. In a certain sense nothing could be better than the widespread discussion the buildings have caused. Architecture has not been a topic to be talked of in the newspapers or even, more's the pity, discussed among educated folk; but the newspapers and every intelligent person have had a great deal to say about these particular buildings, and it may safely be assumed that architecture, having at last made its way into the channels of popular thought and discussion, may now be accepted as one of the great topics of the day. If it were possible to assume that this will be the only result of the Fair,—which of course it will not,—it will accomplish a great and enduring work. And this being so, perhaps it may scarce be seemly to raise a voice of protest against the all but universal chorus of praise now being sung on behalf of the Fair buildings.

Architecture at the World's Columbian Exposition falls naturally under two heads: the buildings and the exhibits. It is with the former that we shall be chiefly concerned, but it is well, first of all, to take a brief glance at the place architecture holds among the exhibits. And one no sooner settles down to study architecture *at* the Fair—a very different thing from the architecture *of* the Fair—than he discovers that the greatest international exhibition, architecturally speaking, the world has seen, the most elaborate group of structures ever erected for such a purpose, the most praised and admired architectural product of our country—perhaps of our time—house the most despicable and absurd architectural collection that it is possible to imagine. A great international exhibition that has provided costly palaces for the display of ob-

jects relating to transportation, fisheries, horticulture, leather, forestry, and sundry less important branches of industry, has no space for architecture itself, save a few handfuls of drawings in the Art Palace,—and the American drawings were not even catalogued in the first editions of the official catalogue,—some scattered and grotesquely inadequate collections of stones in the Mines and Mining building, about which no information save their names and localities is forthcoming, a few electrical devices in the Electricity building, a small collection in the Transportation building, and some miscellaneous collections, scattered apparently as widely as possible, and arranged without the slighest notion of presenting our great art in an integral form, in the Manufactures and Liberal Arts building. This heterogeneous display, divided among a half-dozen buildings, constitutes, with the collection of woods in the Forestry building, and a display of sanitary apparatus in the Anthropological building,—the last of which was not thrown open to the public until the end of June,—all the World's Columbian Exposition has to show for architecture.

One positively runs short of decent adjectives in thinking of such a state of things. Never was a greater opportunity more thoroughly wasted; never could an organizing mind have produced better results with materials that might readily have been obtained. And the contempt which has been put upon the building art at the Fair is the more astonishing since its architecture is one of its chief points. The fact that the exhibition has been planned and carried out on a magnificence of scale and elaborateness of execution that leaves little to be desired, and further that it is, itself, an excellent object-lesson in practical architecture, renders it only the more remarkable that the men who planned it, who carried it out and made it the thing of wonder and of beauty that it is, should so far have neglected their own art as to omit it as a subject to be properly, suitably, and amply illustrated from the scope of the exhibition. Never was greater injustice done the noblest of the arts, never did the architects of any country or of any city—for the blame must rest largely upon the architects of Chicago—so stultify themselves or express greater contempt of an art, which, if it is not an art to them, a thing to instruct people in, is at least a source of revenue and a means to support life.

It is easier to find fault than to accomplish work, but it is not too much to say that architecture should have had a building of

its own. Here would have been gathered, not only the architectural drawings which are now housed in the Fine Arts Palace, but elaborate exhibits of constructive materials and methods,—neither of which are sufficiently well illustrated in the exhibition,—apparatus used in making special classes of buildings useful and inhabitable, sanitary apparatus of all sorts, electrical and mechanical devices employed in the construction of buildings and in daily life, heating-apparatus, and full lines of everything coming under the architect's province. More than this, models of structures might have been shown, illustrative of various classes of buildings. The economic applications and lessons of architecture could have been illustrated, as well as historical forms and exhibits of an historical nature. Finally, to bring our very rough and imperfect classification to an end, the fine and decorative arts bordering upon architecture and actively connected with it might have been included in the same great building. Then, when careful and competent minds had filled in the vacancies in this rude plan, a collection of unrivaled interest might have been shown, and inquiring people taught that architecture is not only the greatest of the arts but the most difficult, that the work of an architect does not consist in sitting down in his drafting room and composing pretty pictures for the pleasing of the eye, but in mastering a thousand different matters, solving a thousand different problems, looking at things in a thousand different ways in order to produce a structure which shall be not only beautiful but useful.

But we have none of this. One can gain a better insight into the progress and work of current American architecture by examining the advertising pages of any of our architectural periodicals than by a visit to the World's Columbian Exposition.

But though the architectural exhibits quite fail to indicate or so much as hint at the real progress American architecture is making every day ; though one can learn absolutely nothing of constructive architecture at the Fair save by studying the internal construction of the buildings,—the latter go a considerable way in making up the deficiency. Instead of supplementing the architectural display, in affording practical examples of certain phases of architecture, they constitute the most important part of what the Fair has to show for the art. And the severest critic must admit that the effect of the buildings and grounds is very fine, that the result is vastly superior to what the most ardent praiser of the Fair led one to expect, and that all hands may be well satisfied

with what they have accomplished. In a certain sense this is true ; in more ways than one the visitor is dazzled by the grandeur of the scene now on view in Jackson Park for the ridiculously small sum of fifty cents ; and further, if one is so fortunate as to witness a night illumination, and above all a display of fireworks in the Court of Honor, words utterly fail to express the sensations created. One forgets then the faults of the buildings, forgets the exaggerations of the faddists, forgets that the reality, as seen in daylight, has many blemishes which more careful study would have eliminated.

It is not necessary here to review the general plan and disposition of the buildings. The illustrated newspaper press has long since made them familiar throughout the civilized world ; a few notes on their architecture may, therefore, be presented without the formality of beginning at the beginning and going over ground that has already been thoroughly traversed.

One has not been very long at the Fair before beginning to wish that there was not so much landscape gardening. Now this is one of the strong features of the Exposition, and the marvelous skill with which the sand-banks on Lake Michigan have been transformed into a park of ravishing beauty has been the theme of many a rapture by many an observer. Beautiful as it is,—and it must not be inferred that I am questioning that element,—it is nevertheless a fact that the landscape gardening and arrangement of the grounds is a distinct drawback to their enjoyment. An international exhibition is a thing of joy, a festival, a jubilee. One does not expect that its inspection will be a laborious task or an undertaking of such magnitude that only the most robust dare attempt it. Yet the distances in the grounds are enormous ; even the buildings around the lagoon forming the Court of Honor are difficult of access unless one is satisfied to follow them in the order in which they are built and never deviate from the program. A remedy would doubtless be swift and cheap means of conveyance from one building to another, and it is possible that some scheme to accomplish this may be in force before these words are printed. But it is one of those things which a landscape gardener, filled with zeal for his art, and especially when given such a great opportunity as Jackson Park afforded, would overlook. Beautiful as the grounds are, they are utter failures when judged by the standard of utility. If perchance you don't believe it, go and try it, and I will warrant that in a day or so you will appreciate the point.

To a very great extent architectural interest centers in the Court

of Honor. Not that the finest buildings on the grounds are located there, but the most important ones—except the Fine Arts Palace—face it, and it has been made the central point for architectural display. Yet the finest things in the Court are not the buildings, but the sculptures which decorate it. Save those of Agriculture and Machinery, none of the buildings are in any way remarkable. The Administration building is a serious attempt to surround a dome with utilitarian offices, but the dome loses very much in being octagonal, instead of circular; its perspective is constantly bad and distorted in consequence, while it is further injured by lack of a finish; a lantern or even a statue would have helped it very materially. Internally the effect is disappointing. The wall decorations are insignificant, much of the coloring of too light a shade, and the fresco which is intended to decorate the ceiling almost wholly out of sight.

Machinery Hall is one of the few pleasant disappointments of the Fair. No drawing does this building justice, one shown by the architects in the Fine Arts Palace being, if anything, especially bad. Seen in the reality, it shows itself to have great dignity and beauty of design. The lateral colonnades are very well done, though the coloring of the walls behind them is lighter in tint than it need have been. The towers and domes are vastly more successful and pleasing in the structure than in the drawings. The architectural decoration of these parts is rich and effective, and is in striking contrast with the sculptural decoration of its near neighbor, the Agriculture building. The towers and the building in general are, perhaps, rather too plentifully decorated with figures of angels, but they do not detract from the generally satisfactory result. The porches are the most unfortunate part of the design. These—I refer to the rectangular porch facing the Agriculture building, and the semi circular porch on the long façade—do not grow out of the building, but are "stuck on," as it were. They are ornamental appendages, very good in themselves, but without organic connection with the structure they decorate.

More than any other building on the ground, the Agriculture building impresses one by its sculpture. Architecturally the building is very successful, and the design lends itself to a rich sculptural ornamentation that has been applied wherever available. And this sculpture is not architectural decoration, but groups that, most of them, would look as well off the building as on it.

In this respect the building stands alone among those on the grounds, for here the sculptor has been given his greatest freedom, and here he has most amply availed himself of his opportunities. That these have been too many can scarcely be questioned. The piers which break the arcades of the façades, for example, and each of which carries a sculptured group, seem rather to be designed for that purpose, for they are clearly not needed for structural reasons. The walls of the porticoes of the building have been treated in color in a rich, brilliant, and effective manner, so that in sculpture and painting the Agriculture building stands alone among the buildings on the Court of Honor. It is a most interesting experiment in decorative architecture, if such a term may properly express the coördination of architecture, painting, and sculpture in an external effect.

The Manufactures building—which from its vast size must be, by the usual American standard, the best building on the grounds, if not the best in the world—is one of the least successful. Neither painting nor sculpture appears in its exterior, save for a series of eagles on the central pavilions. It was a wise restriction, and one of great benefit to its opposite neighbors, Agricultural and Machinery halls. Great though the building is in size, it does not show it. The roof is much too high, and, though the enormous arches are wonderful pieces of construction, there was no reason at all for making them as high as they are. Nothing within the structure calls for such great height, while the design is one that dwarfs the building exteriorly and helps to hide its true proportions. The design of the exterior is ruined by attempting to carry two series of arches one over the other. Nothing is so likely to result in failure as this, and the Manufactures building is no exception to the rule. The design, as doubtless will be remembered, consists of a series of segmental arches, carrying an arcade of round arches. The juxtaposition of the two forms of arch is very bad. Had a straight line been used for the lower story, with an ornamental frieze to break the monotony of the wall surface, leaving the upper arcade as the single arch in the façades, the result would have been much more successful. The really remarkable feature of this building is its construction, of which, unfortunately, few save architects and engineers will take notice. As it is, a vast number of people will go away from Chicago this summer convinced that the Manufactures building is the best and most successful thing on the grounds, and for no other

reason than that it is the biggest. Is the best-looking man he with the largest mouth? What has size to do with beauty or in determining the relative excellence of a piece of architecture?

Of the Mines and Mining and Electricity buildings, the two remaining structures upon the Court, nothing need be said save that neither does justice to its authors. Both are comparatively small buildings, and hence are necessarily without the interest attaching to the larger ones. Nor is it needful to enlarge upon those abominations, the Government building and the Illinois State building. Yet these should not be hastily condemned, since in showing the natural outcome of officialism in architecture they are really the most useful structures upon the grounds. The strange thing about these buildings is, not that they were erected, but that it was within the capacity of human brains to conceive of anything so dreadful. The rotunda of the Government building is a miracle of the absurd in architecture, and that of the Illinois State building a good second to it. The Fisheries building must be dismissed in a very few words. Designed in a Romanesque style, the architect has departed from the traditions of the Court of Honor. Judged by the standard of utility, his building cannot be pronounced a success. There is no reason in the arcades which connect his wings with the main edifice, save the production of an awkward plan that is both confusing and wearisome to the visitor. The most characteristic feature of this structure is the carved decoration of all sorts and conditions of fish and sea-beast, which have been pressed into service for architectural purpose. As the ordinary elements of architectural ornament, those drawn from geometrical forms and from vegetable life, have been the results of study and work for some thousands of years, it is not to be supposed that a single architect, and a busy one at that, can successfully transform fish life into forms equally successful in a single venture.

Then comes the Palace of the Fine Arts. If one is to believe the guide-books, no voice has yet been raised in disparagement of this "crowning glory" of the exhibition. An eminent faddist, hailing from the metropolis, tells an awe stricken world that, "if the Greeks had built a dome, they would have built it just as it has been built in this building." An eminent architect, himself the author of one of the most successful buildings on the grounds, tells us "it is the greatest thing since Athens." There is no limit, as may be seen from these quotations, to the praise uttered in be-

half of the design of this building. The design is good, but it by no means warrants the extravagant praise gushed out for it. Its chief strength lies in its quietness, in the subdued manner in which the parts have been treated, and the harmony with which they have been brought together. The dome, at which both criticism and the building culminate, is marred by its base, consisting of two semi circular rings, one of less diameter than the other, and which unpleasantly suggest two low bandboxes placed one on top of the other, and an inverted soup plate over all. The annexes attached to the building, and which are really an integral part of it, stretch away in the rear in an alarming fashion and detract very much from the design. It is an earnest effort to produce a purely Greek building, but it is very far from warranting the absurd praise that has been given to it.

Of the great buildings upon the grounds there remains only to notice the Transportation building. Somewhat removed from the other chief buildings, it stands alone both in location and in art. It is not too much to say that, without any exception whatever, this is the most ambitious and successful example of polychromatic architecture in America. For in this building, unlike any of the others, the color decoration has been carried out on a most elaborate scale, and, while it is decorated with some pieces of sculpture, and its great Golden Doorway is itself a masterpiece of the sculptor's art, it is the color decoration that gives it its character and its beauty, lifts it out of the rut of classicism, into which the other Fair buildings drift, and makes it the most remarkable and interesting structure upon the grounds. No bolder scheme than this richly-colored building has been undertaken in American architecture, and the Fair teaches no more notable lesson than is impressed by this great work of art. The Golden Doorway, as perhaps need not be stated, is the central feature of the design. Here, in a series of recessed arches, the architect has woven a carved decoration, partly geometrical, partly foliated, of marvelous beauty and ingenuity. These arches are deeply recessed so as to make the door opening in the center only of sufficient size to be properly useful. A broad band of ornament entirely surrounds the central portion, thus effectively framing the main doorway. All this is in decorative relief that is strictly architectural.

But it is to the polychrome decorations of the wings of the building that the attention of the architect will be chiefly directed. The boldness of the conception startles one at first, for the idea of

a building completely decorated with color is a novelty in our latitude. Yet Mr. Sullivan has shown himself a man not only of genius but of courage, and his work justifies him in its complete and rare beauty. The chief feature of the design is a very broad band of painted ornament carried around the building immediately under the molded cornice. This is a rich and beautiful conception, of complicated, yet well-arranged design, and exquisitely colored; though including a great variety of tints and tones, it is wholly harmonious. Between the windows is a series of angels with extended wings, each carrying a streamer with the name of some man great in transportation painted on it. These are exceedingly dignified, well-conceived figures, and their white robes admirably relieve the brilliant color of the frieze. The exposition contains nothing nobler, nothing more successful than this building, and there is nothing upon the Fair grounds that will more amply repay study. It is unjust to compare it with the other buildings or to place the other buildings in comparison with it. The architecture of the Court of Honor is wholly distinct in conception from the architecture of the Transportation building. The beauty of the one is not the beauty of the other, and by endeavoring to impress a single standard of measurement upon their excellences one loses the value of each. Those will profit most who, in seeing the white buildings, will forget the polychrome structure, and in viewing the latter will see only it.

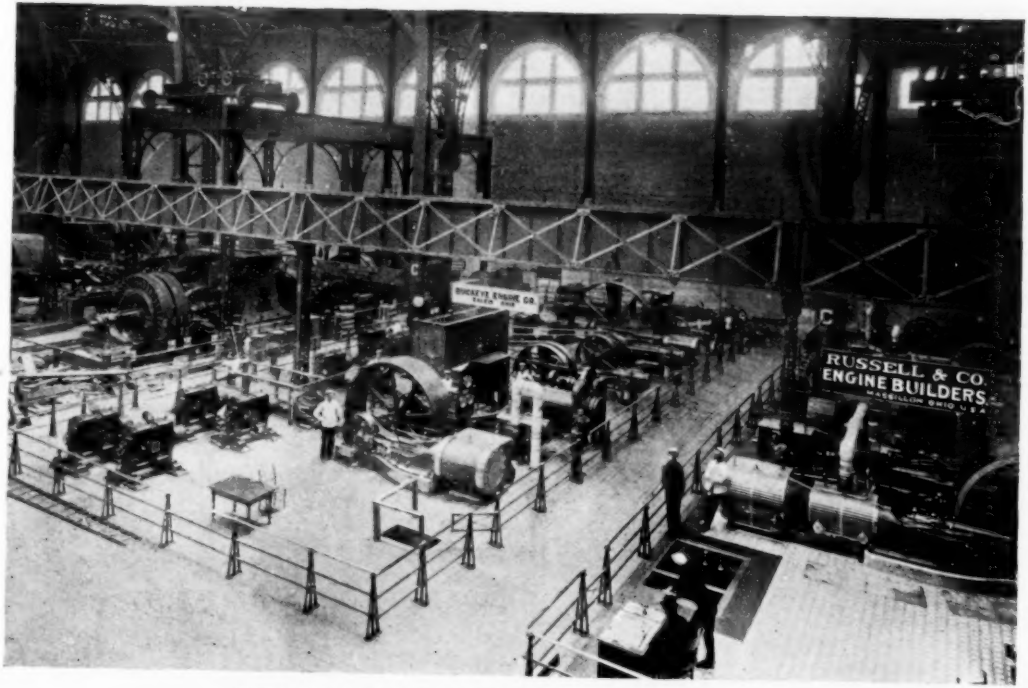
A PORTION OF THE POWER PLANT, MACHINERY HALL, WORLD'S COLUMBIAN EXPOSITION.

THE ELECTRIC AND POWER PLANT AT THE WORLD'S FAIR.

By W. S. Monroe.

IN 1876 President Grant started the machinery of the Centennial Exhibition by turning a false throttle-valve, while an engineer beneath the floor admitted steam to the cylinders. In 1893 President Cleveland pressed an electric button, and by that touch alone turned the wheel of the big engine one thousand feet away, and started the pumps of the fountains one hundred feet beyond. The great triumph of the exposition of 1893 over 1876 is power which has developed in electrical science within the seventeen years. In 1876 the Corliss engine of 2000 horse-power drove all of the machinery of the Centennial Exhibition, and furnished all the power used. In 1893 the Reynolds engine of 2000 horse-power that turned to the president's touch drives two electric dynamos which form but so many units in the greatest electric plant in the world, and which employ less than 7 per cent. of the total energy of the plant. In 1876 the practical utility of electricity was confined to electric bells and annunciator-calls. The telephone was an experiment, and people eagerly paid for the novelty of talking over a line from the main building to the Philadelphia city hall. The electric arc-light was a toy, the electric railway was practically unknown, and the incandescent light even more so. Electrical science was then in its infancy, and the world may look with wondering eyes upon the exhibition of the development which it has made within these few short years. The electric system for the exposition grounds and buildings at Chicago stands a climax to the thousands of electric stations which, as if by magic, have sprung up throughout the world.

The problem of the electric plant was a difficult and complex one. The continued and prolonged uncertainty as to the demands to be made upon it, the consequent frequent additions to its capacity which were necessary, and the difficulty of obtaining the proper machinery exhibits required for particular situations, rendered the plant more a growth than an organized unity from its conception. The electric plant, after much discussion, was located along the south side of Machinery hall, the engine and dynamo rooms occu-



ENGINES AND DYNAMOS IN MACHINERY HALL, WORLD'S COLUMBIAN EXPOSITION.

pying a space 100 feet wide and extending the full length of the main building and about 250 feet into the annex,—a total length of over 1000 feet. It was first thought that the plant would be confined to the main building, but subsequently the addition of the annex space was found indispensable. The boiler-room is an extension on the south of Machinery hall, 86 feet wide, running almost the length of the building. The addition of the boiler-house annex, which is a continuation along the hall annex, was found necessary at a later date.

The engines of the electric plant were furnished free of cost by their manufacturers as working exhibits. It was found impossible to obtain the boilers on like terms, and, after receiving several bids, contracts were made with eight companies for boilers, based on a guaranteed evaporation of water, at the rate of $5.33 per horse-power of 30 pounds of water per hour. The list of boilers, as installed, with the guaranteed water evaporation per hour, follows:

Makers.	Boilers.	Pounds Water.
Abendroth & Root Co.	4	45,000
Gill Water-Tube Boiler Co.	4	45,000
Hiene Safety Boiler Co.	8	112,500
National Water-Tube Boiler Co	4	45,000
Campbell & Zell Co.	9	112,500
Babcock & Wilcox Co.	10	90,000
Stirling Boiler Co.	4	54,000
Hiene Safety Boiler Co. (second contract)	4	56 200
Climax Boiler Co	3	60,000
Stirling Boiler Co. (second contract)	2	27,000
Total.	52	647,200

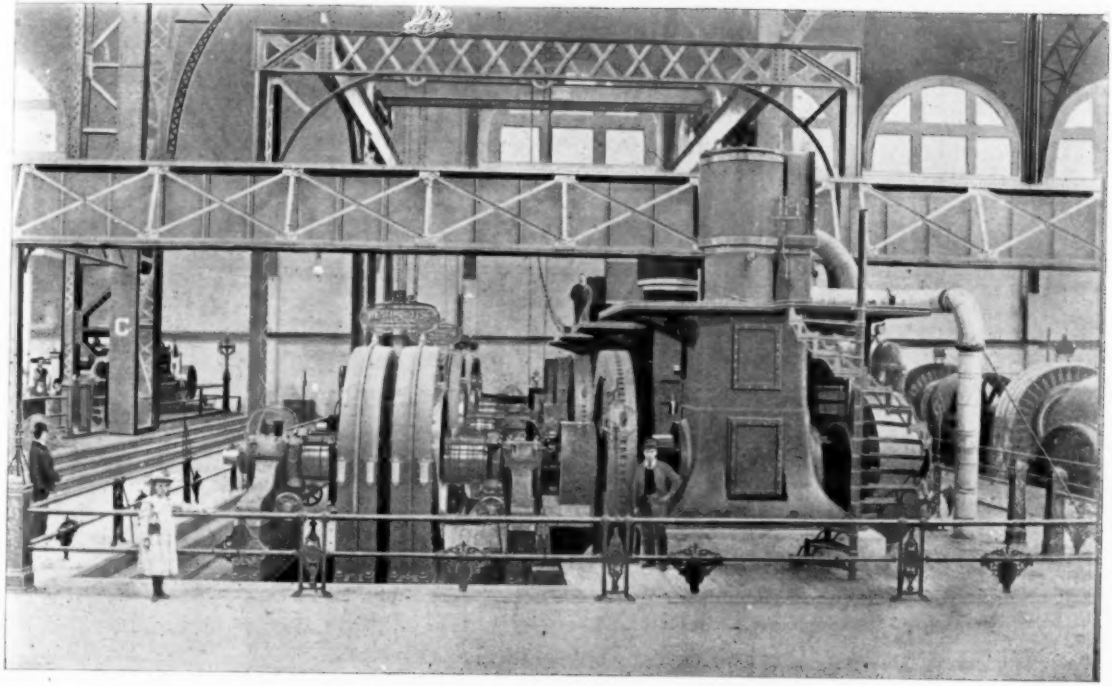
This total of 647,200 pounds of water per hour is equal to about 20,000 commercial boiler horse-power, but, as by far the greater number of engines in the plan are compound and triple-expansion condensing engines, using only from eleven to eighteen pounds of steam per hour for each horse-power, the boilers are amply available for 50 per cent. above their commercial rating.

The boilers are arranged in a continuous row, fronting toward Machinery hall. They are placed in the order given above, beginning at the east end, the first seven batteries in the main room and the others in the extension. The floor of the firing-room is twenty-five feet wide and is nine feet below the main floor of the Machinery hall, a gallery twenty feet wide on a level with the latter extending out into the boiler-house, so that a view of the boilers is had from this gallery, most of which is given up to promenade, though some feed-water heaters and other apparatus are located upon it.

VIEW OF THE MAIN BOILER-ROOM, FROM THE WEST END.

The fuel used in the furnaces is natural oil exclusively. This is delivered to the grounds from the station of the Standard Oil Company at Whiting, Indiana, through a pipe-line which also supplies the Illinois Steel Company's works and other factories at South Chicago, and the Hyde Park gas works. The oil is received at the grounds in twelve storage-tanks located in underground vaults at the southeast corner of the park, 3200 feet from the boiler-house. The tanks are each eight feet in diameter and twenty-five long, and have a total capacity of 112,500 gallons. As the power plant is usually operated, the tanks contain from three to four days' supply of oil, but, when the plant is run to its maximum capacity, it will empty one tank every hour. A small pumping-station is located near the oil-vaults for the delivery of the oil to the boilers. It is first pumped into a stand-pipe thirty feet high, whence it is delivered directly to the burners through a five-inch pipe, the stand-pipe maintaining a uniform pressure at the boilers. The oil-pumping station is fitted with duplicate delivery-pipe, boilers, pumps, and piping, and with by-passes and cross connections and with an arrangement by which oil can be delivered from tank-cars, so that the failure of any portion cannot stop its operation. The oil-burners used under the boilers are of various makes, having been almost entirely left to the choice of the boiler contractors.

To return to the engine-room, the engines and dynamos were laid out in the space allotted as rapidly as the machinery was definitely decided upon, and as systematically as the conflicting elements of the requirements of the machinery and the constructional details of the building permitted. The dynamos were supplied under contracts with different electrical firms to furnish all apparatus and instruments needed for lighting the different portions of the grounds and buildings. The incandescent lighting for the entire park was let to the Westinghouse Electric Company, the contractor not only to furnish the apparatus, the dynamos, lamps, switch-board, etc., but to do the wiring as well. The arc lighting was divided among six firms,—the Brush Electric Company, the Fort Wayne Company, the Standard Company of Chicago, the Thomson-Houston Motor Company, the Excelsior Company of New York, and the Western Electric Company. The electric-power generators were placed with the Mather Electric, the Eddy, the C. & C. Motor Company, the Westinghouse, and the General Electric companies. The contracts for electrical apparatus were all made for a certain amount of machinery with the possible addition at contract terms



DIRECT-CONNECTED WESTINGHOUSE ENGINES AND DYNAMOS.

of a specified amount, if the exposition should find it necessary. These additions were all found ultimately to be required.

At the outset it was decided that the engines for the electric and power plant could be obtained from those offered as exhibits. The real difficulties in the way of obtaining the kind of engines adapted for the special work and certain situations were not fully apprehended, but the plan was carried out to the end.

The incandescent-lighting machinery is the largest and most prominent section of the plant. The Westinghouse company decided that all the dynamos furnished by them should be 10,000-light alternating-current machines requiring about 1000 horse-power each. Ten of these machines were at first to be furnished, but two more were afterward added. The E. P. Allis Company of Milwaukee had early promised to furnish a 2000-horse-power engine, the Buckeye Engine Company and the Fraser & Chalmers Company each 1000 horse-power. Other engines of that size were also obtained from the Atlas Engine Works and the McIntosh & Seymour Company, when the Westinghouse agreed to furnish engines direct-connected to the dynamos for the four remaining machines. The two dynamos subsequently added were also direct-coupled to Westinghouse engines.

The big Allis engine had been promised the place of greatest prominence and was located under the south one of the three domes in the center of the building. On account of the large foundation required and the necessity of keeping the fly-wheel pit above the water line, the engine was set on a platform about 2½ feet above the main-floor level. The engine is a horizontal quadruple-expansion double-crank engine ; the cylinders are 26, 40, 60, and 70 inches in diameter by 72 inches length of stroke. The fly-wheel is 30 feet in diameter with 75 inches face, is built in twelve sections, and weighs eighty tons. The shaft is eighteen diameter in the bearings and twenty in the wheel. The engines drive its two Westinghouse dynamos by two belts 72 inches wide, running one over the other, the dynamos being set in tandem. The longest of the two belts is about 160 feet, and their speed is over a mile a minute. They were furnished free of cost by the Page Belting Company.

The Fraser & Chalmers engine, belted to one of the Westinghouse dynamos, was located beside the Allis on the same platform. It is a four-cylinder, triple-expansion engine, the intermediate and two low-pressure cylinders being made from the same pattern, 34

inches in diameter and 60 inches stroke. On this central platform were also placed the three small direct-connected engines and dynamos, the current from which is used to excite the fields of the big alternators, and two 15x30x16 which run two 4000-light dynamos originally put in for temporary service.

Immediately west of the platform is a "block" containing the four direct-connected Westinghouse engines and dynamos. These machines stand side by side and form a very notable exhibit. The engines are of the vertical, steeple compound type, the low-pressure cylinder being above the high-pressure and standing 16 feet high above the floor. The cylinders are 21½ and 27 inches in diameter by 22 inches length of stroke, and the shafts run 200 revolutions per minute. The block containing these engines, dynamos, and the condensers, an aggregate of 4000 horse-power, is 47 feet wide by 90 feet long, and contains as much power as the big central block, which is 135 by 90 feet. The economy of floor space in the vertical direct-connected type is noticeable.

Next west to the "four 1000 horse-power Westinghouse block" is one containing the Buckeye, Atlas, and McIntosh & Seymour engines, each belted to one of the Westinghouse dynamos. The Buckeye engine is a four-cylinder triple-expansion. The Atlas and McIntosh-Seymour are each double-tandem compounds. West of these engines are the two additional direct-connected machines which complete the incandescent plant. The Westinghouse dynamos are controlled from the largest switchboard ever constructed, which is located on an elevated platform against the wall to the south of the main block. The board is of white marble and is in two sections, the lower one controlling the dynamo leads and the exciter wires and the upper one the line mains. Nearly 250 cables run from this board.

The arc-lighting plant is very much divided, no attempt being made to keep it together, though each make of dynamos, with the engines which drive them, occupies a separate block and is a distinct station with its own switchboard and accompanying apparatus. The arc dynamos are all 50- or 60-light machines, and, where engines of more than 200 horse-power are employed, a counter-shaft is necessarily used, being placed in the basement in all cases, the belts running back through the main floor to the machines.

There are sixteen Brush dynamos belted direct to five Ball and Wood engines at the east end of the incandescent plant, and at

the opposite end is a block containing the Fort Wayne dynamos driven by five Buckeye engines of as many different types and sizes. These five engines, with the triple-expansion Buckeye, form in some ways the most complete engine exhibit in the building. Next to the Fort Wayne block is one containing twenty Standard dynamos, four of which are belted direct in two tandem pairs from a 15x14 Erie City engine, and the others are driven by counter-shafts from two Russell engines, one a tandem compound of 200 horse-power and one a double tandem of 600 horse-power.

The rest of the arc-lighting machinery is in the Annex. There are in one block sixteen Thomson-Houston dynamos driven by three Lane & Bodley Corliss engines,—a simple, a tandem, and a cross-compound,—and next to these ten more Thomson-Houston machines and six Excelsior machines driven respectively by a tandem-compound Atlas engine and a cross-compound built by the Bass foundry. The Western Electric dynamos, driven by a Watertown double-tandem compound, an Erie City, a New York Safety, and three small Russell,—all simple engines,—occupy the space at the extreme west end of the power-plant.

The electric-power generators are all located by the east end of the plant east of the Brush block. There are two tandem-compound Woodbury (Stearns Manufacturing Company) engines driving four Mather generators, having a total of 800 horse-power. Two Ide engines, a tandem-compound, and a simple, drive four "C. & C." generators of 100 horse-power each. The Phœnix Iron Works furnish a good exhibit of three engines, a simple, a tandem-compound, and a four-cylinder triple-expansion,—which are used to drive four Eddy generators of 250 horse-power each. The E. P. Allis Company have a 500 horse-power cross-compound engine with a Westinghouse multipolar railway generator on the engine-shaft. There are four Edison 200 horse-power generators driven by a Ball cross-compound and an Armington & Sims simple, and also an Edison double multipolar generator aggregating about 1000 horse-power directly driven by a triple-expansion engine of the General Electric Company's make. These electric-power generators furnish current for motors driving line-shafts, elevators, and similar machinery in the Manufactures, Agriculture, and other buildings and for charging the storage-batteries of the electric launches.

Besides the engines in the electric plant, there are several which drive the line shafting in Machinery building. There is about 6500 feet of shafting divided into about eighteen sections. Two

sections are driven by electric motors, but all the rest are driven by engines of various sizes located at points most convenient to the shafts which they drive.

There are among these two tandem-compounds of about 300 horse-power each from the Harrisburg Foundry and Machine Works, and B. W. Payne & Co., Providence Engine Company, Golden State Miners and Iron Works, the Bates Machine Company, and Erie City Engine Works. Each is represented among the "line-shaft engines." The Sioux City Engine Company have a 24x 48 engine which drives two long shafts from a double-crowned fly-wheel, the belts extending in opposite directions from the wheel. This Sioux City engine is the largest single-cylinder engine in the building. The E. P. Allis Company have driving one shaft a small vertical box engine of an entirely new pattern, designed to compete with the small engines of the cheaper grades.

The English and German commissioners furnish the engine power to run their respective exhibits. The Germans have a small triple-expansion marine engine of 150 horse power, made by Shichau & Co., which drives three parallel shafts with a rope drive of the endless-rope system which is now becoming quite common in this country. By the side of this engine there is another of 1000 horse-power of exactly the same design as the small one. The large engine drives a Siemens & Halske direct connected arc-dynamo, which is used by the exposition company for lighting the terminal station. The English commission have three engines to drive their shafts. The most prominent of these is a Galloway compound-engine with superposed cylinders, which has a drive of eight parallel ropes. The other engines in the English space are Willans & Robinson vertical high-speed compound-engines. These engines run at 300 revolutions per minute and are made with very short stroke to reduce the piston speed.

Besides the electric and power machinery there are in the power plant several air-compressors, four of varying sizes from the Norwalk Iron Works, which furnish compressed air for the sewerage system. There is a large double Corliss compressor from the Ingersoll-Sergeant Company, and another Corliss, compounded in both air- and steam-cylinders, from the Rand Drill Company. These latter furnish air for running elevators in the Transportation building and various exhibits in that and the Mines building.

The total capacity of the engines in the electric and power plant, as taken from the economical (not the maximum) rating of

their makers, is somewhat over 29,000 horse-power. Besides, a considerable amount of steam power is used by the pumping-station and by exhibitors in Machinery hall and the Mines building, to which latter a 9 inch steam-pipe is run from the boiler-house, a distance of about 1500 feet, so that the plant is fairly estimated at 30,000 horse-power.

All the piping for this immense system of machinery is, as far as possible, located beneath the floor. The main steam header is located under the platform in the boiler-room, the boilers feeding into it by pipes, which cross the boiler-room near the roof and drop into the header. This header is 36 inches in diameter, built of boiler iron, and runs the entire length of the boiler-room and annex, about 800 feet. On account of the expansion, however, it is divided into seven sections, the longest of which is 150 feet, and this one expands nearly four inches under steam at full pressure. The adjacent sections of the header are connected by expansion loops of 10-inch wrought-iron pipe, which serve to equalize the pressure. Laterals are taken out of the top of the header and run across the power plant under the main floor with branches to the different engines. The condensers are supplied with water from seven Worthington pumps located at the extreme east end of the power plant, which take their water-power from the lagoon east of Machinery hall. There is a double 24-inch main running from these pumps down each side of the basement of the engine-room. The overflow-pipe which takes the water from the condensers is, at its largest section, 40 inches in diameter. There are about thirty condensers of varying sizes, representing nearly all the prominent makers and types, in this country, whether of surface, or injection-condenser, or air pumps. Most of the condensers are placed in the basement, though a pit is cut in the main floor, so that the condensers may be seen from above. The condensers for the big vertical Westinghouse engines are placed above the main floor and are the largest in the plant. There are, among these, two Wainwright surface condensers, with Blake combined air and circulating pumps, and two Wheeler surface-condensers, one with a Blake and one with a Knowles air-pump. On the other two of these engines are Worthington jet-condensers.

The boiler-feed pumps and feed-water heaters should also be mentioned among the machinery exhibits of the power plant. The feed-pumps are in the firing room, just opposite the boiler-fronts. Prominent among these is a large triplex-geared power-pump by

the Goulds Manufacturing Company, which is driven by a small Ide engine direct-coupled. Among the others are exhibits from nearly all the makers of small steam-pumps, showing every variety in design and construction.

The feed-water heaters are all exhaust-heaters, and most are of the pressure pattern. Though much the larger proportion of the engines are condensing, there are several high-pressure engines, and the exhaust from these as well as from the feed-pump is used for heating the feed-water. Most of the condensing-engines also have a connection to a free exhaust to provide immunity from accidents to the condensers. Among the heaters, two large Baragwanaths and a Kroeschell are conspicuous as examples of the pressure type, and a Hoppes and an immense Webster of the open type. There is also a big double Colles heater, which is a combination of both forms.

To the engineer possibly the most interesting exhibit is found in the vitals of the plant, concealed in the basement. Though difficult of access and uninviting, even threatening in some ways, there is an inspiring impressiveness in the net-work of huge pipes, —steam, exhaust, injection, and overflow connection,—the whirr of tons of rapidly-revolving fly-wheels, the clatter of a hundred belts and dizzy spin of the counter-shafts, the measured beat of condenser-pumps and the hiss of steam from an occasional leaky joint, all among the dark shadows of the huge masonry piers which form the engine foundations. Beside the power plant, the entire Machinery building is intersected by a net-work of steam-pipes for supplying steam to exhibitors. The entire building contains 900 feet of 16-inch lap-welded pipe, over a half mile of 12-inch and 14-inch pipe, and more than a mile of 6-, 8-, and 10 inch pipe.

There might also be included in the electric and power plant the distribution of electric light and power throughout the grounds. The arrangements and setting of the thousands of lights, the miles upon miles of wires and cables which interlace the grounds to its uttermost extremes, and the methods of carrying these in ducts and conduits, and the wire-walled electric subway, the limits of this article scarcely permit us to consider. To Mr. C. F. Foster, the mechanical engineer, and Mr. R. H. Pierce, the electrical engineer, and also to Mr. F. Sargent, who was formerly the mechanical and electrical engineer, are due the design, construction, and erection of this great work,—the greatest of modern power plants.

ELECTRICITY.

Conducted by Franklin L. Pope.

SOME of the technical journals which devote themselves especially to electrical matters have taken exception to certain observations which have from time to time appeared in these notes, in reference to the tendency which has become increasingly apparent of late years, to establish electric-lighting and electric-railway plants under conditions that forestall the possibility of an adequate return to the capital invested in them. One of the leading electrical journals, while not attempting to traverse the essential accuracy of the statements made, contends that one remedy suggested—that of raising the price of electric-lighting service to a remunerative point—is not to be thought of. It asserts that the real source of the trouble lies in the cheap and unscientific manner in which these plants have been installed, and in the false economies and generally inefficient management in vogue in many of the smaller central-station plants. It apparently overlooks the fact that the first count of this indictment, if true, would constitute a scathing arraignment of the engineering and business methods of the half-dozen or so "parent" companies of the country, under whose auspices and instructions nearly all these local plants have been installed. As to the second point, it is difficult to believe that all or even any considerable number of the small plants are seriously mismanaged. There are too many of them in the same predicament, and the figures run too near alike in the different places to render this conjecture a plausible one. The amount of careful and intelligent service rendered on many of these small plants by their attendants, for inadequate compensation, would surprise one who had never had occasion to investigate the subject. One thing is certain, and that is, if 1 cent per lamp-hour is a fair price for incandescent lighting in a city of 100,000 inhabitants, it is much too low a figure in a rural municipality of 5000. Another journal has attempted to refute an opinion expressed some months ago in these notes that the electric-railway business was in great danger of being overdone, having reference more particularly to the extension of new lines not in towns, but along country highways, and through sparsely settled districts intervening between such towns. Our contemporary professes to quote from the street-railway returns of Massachusetts to prove what no one has undertaken to dispute, viz.,—that the aggregate percentage of net earnings to total cost is 6⅛ per cent. for the electric lines, and only 5½ per cent. for the horse lines. This reminds one of the assertion of the knight of the road that the average amount of his income and Vanderbilt's, taken together, was several hundred thousand dollars per annum. We do not know from what source our contemporary derived his figures, but our copy of the Massachusetts report for 1893 gives 592.3 miles of electric- and 322 miles of horse-railway, instead of 235 electric and 262 horse, as he has it. The average cost per mile of electric-railways, including roadway and equipment, is given by him as $30,631, and that of horse railways as $29,550, which is manifestly absurd. The Massachusetts railroad commissioners' report says that the average cost of *all* street-railways, including equipment, is $47,356 per mile, a somewhat important difference. We have no doubt, however, that the difference in the ratio of cost to net earnings, in the case of the electric lines now in operation, is fully as great and even greater than our contemporary states, and it is for the very purpose of maintaining this average, by advising investors to be cautious about putting their money into unprofitable lines, that we called attention to the matter as we did. The installation of non-paying electric

plants is quite as injurious, in the long run, to the stockholders of the electrical manufacturing companies as it is to the immediate investors. It is certain, in the end, to make it extremely difficult to raise capital for legitimate and necessary undertakings of this character. The real trouble is, in our opinion, that the electrical industries of to-day are being carried on for the pecuniary benefit of promoters, salesmen, and drummers, rather than in the interests of the capitalists whose money is invested in the business, or of the public which is entitled to good service at reasonable prices. The financial prosperity of the great electrical companies must ultimately come to depend wholly upon that of the local electric-lighting and -power companies, and the fact cannot be gainsaid that the official returns demonstrate that these are by no means as prosperous as they should be. It is much the wiser policy to determine the cause of the unfavorable conditions which exist and apply the proper remedy than it is to seek to deny the facts.

MR. EDISON has been giving some advice to would-be inventors through the columns of a metropolitan contemporary. Some of his advice is excellent, and some of it is quite otherwise. The thing to seek for, he says, is the machine or the process which will save labor. This is emphatically true. By far the larger share of the so-called "inventions" which cumber the records of the Patent Office are either devices for doing that which nobody cares to have done, or else they embody a somewhat different, and no better way, of doing that which was well enough done before. Such contrivances, however ingenious they may be, are a mere waste of time and money. The money is made, says Mr. Edison, in the little inventions and not in the great ones. This is also true in a measure, but not for the reason alleged by him, which is that, if the invention is of real importance, it will be pirated as soon as a patent is applied for, while the inventor can only establish his rights after a long, tedious, and expensive course of litigation. Therefore Mr. Edison advises that an invention had best be kept and worked in secret, and no patent applied for. Mr. Edison, however, has conspicuously neglected to follow his own advice, having taken out, up to date, some seven or eight hundred patents, probably a greater number than has been taken by any other inventor in the world. He has been constrained to do this for the reason, if no other, that at least 90 per cent. of all inventions made are of such a nature that it is quite impossible to keep them secret, if any use whatever is to be made of them. How would it be possible to maintain secrecy in respect to such inventions as the telephone, the telegraph, the cotton-gin, the reaping-machine, the electric-motor, and a thousand others like them? The pirating of patented inventions, of which Mr. Edison so loudly complains, is not chargeable to our patent laws, and still less to our courts. It is due to unregenerate human nature, which causes each man to be consumed with an unappeasable desire to appropriate the fruits of his neighbor's industry, no more in respect to patent-rights than to every other valuable result of human endeavor. The whole machinery of our courts of justice is maintained for no earthly reason except to prevent and punish the infraction of one man's rights by another. Experience shows that, when a really original invention has been made, and the patent claims are properly drawn to protect it, would-be infringers are apt to be very wary of incurring the penalties of transgression. If a man buys a farm and accepts an incorrect deed,—one which fails to describe the property, or which describes some other property which he has not bought,—it does not look well for him to cry out against the laws of the land or the procedure of the courts, in case some sharper person than himself takes advantage of his defective title to oust him from the premises. Mr. Edison observes parenthetically that his own fortune has been made in manufacturing and not from patented inventions, but we are inclined to believe that, if the articles he manufactured had not been protected by patents, he would not have found the business of manufacturing them extraordinarily profitable. It

is really, we think, rather late in the day to question the policy of the patent law of this country, which, in spite of its admitted defects, has unquestionably been the principal factor in making us the leading industrial nation of the world.

THE report of the American Bell Telephone Co. states that it has now under rental no less than 552,720 telephones, an increase of over 40,000 for the year. There are now 812 exchanges, and an aggregate mileage of wire of 307,791,—90,216 miles of which is underground. The estimated number of exchange connections made for conversation is about 600,000,000 per year. Great progress has been made the past year in the establishment of trunk lines connecting the different exchange systems, and the number of inter-exchange connections made during the year was about 13,000,000. The use of the telephone by its subscribers appears to be increasing, as its convenience becomes more appreciated. Each subscriber, on an average, is placed in communication with others in the same exchange sixteen times per day, while six years ago the average was only 11.6. With the recent extensions and additions to the system, more than one-half of the total population of the United States have now been brought within talking distance of each other, and it is a fact that a man may sit in his office-chair in New York and speak directly to any one of 125,000 telephone subscribers, some of them over a thousand miles distant. The gross revenue for the year from telephone rentals was in round numbers $3,000,000, being a little less than $6 per instrument, from which it appears that this rental, which includes the patent royalties, is but a very small fraction of the annual cost of the service to subscribers. The high price in New York city, as we have more than once pointed out, is largely due to the enormous expense entailed upon the telephone companies by the subway system.

A WRITER in the London *Electrical Review*, after a careful examination of the whole matter, reaches the conclusion that in England the electric light in most cases costs considerably more than gas, but points out that the difference in cost to the householder is nearly counterbalanced by the avoidance of the constant expense of repainting, repapering, and redecorating the interior walls of rooms, which have been deteriorated by the smoke from the gas-burners.

THERE has been a vigorous contest in the legislature of Connecticut over the provisions of the proposed general statute for the regulation of electric-railway enterprises. As finally passed, the bill permits the paralleling of existing steam railroads, provided the courts can be convinced that the public interests require it in any particular case, which is perhaps the wisest disposition of the matter that could have been made. Freight may be transported under similar conditions. Our own view of the matter is that the steam-railroad companies will ultimately find it for their interest to control all the profitable and well-located electric lines, and will operate them on a coupon-ticket system as feeders and distributors of their local passenger traffic. That this might be done in many cases, with the greatest possible advantage to all concerned, is obvious upon the most casual consideration of the matter.

THERE are not a few people who imagine that, if the telegraph service were only turned over to the government, we should soon have vastly increased facilities at lower prices. But the experience of some other countries seems scarcely to justify such an assumption. The well-known London correspondent of a leading New York newspaper, who is making a pilgrimage through Germany, states that in Berlin, a city of 1,750,000 inhabitants, there are only fifty-eight telegraph-stations, all told. In Dresden, with 250,000, there are only ten, and in the important city of Hamburg, which is twice as populous as Dresden, there are only fourteen. The fact is, as every unprejudiced observer is well aware, that the telegraphic service of the United States, in spite of all its faults and shortcomings, is, all things considered, far in

advance of that of any other country in the world. Not only is there almost a superabundance of offices in almost every town of commercial importance, but in all large cities one has but to touch a button in order to secure, within a minute or two, a messenger to convey the sender's telegram, without charge, to the nearest office, a thing undreamed of in any other country. The charges, moreover, are not exorbitant, as is frequently alleged; there are in fact few kinds of business in which the actual percentage of profit is smaller than it is in telegraphy, as carried on in the United States at the present day.

THERE is now attached to the French navy a torpedo-boat which is propelled by electricity and carries a store of compressed air for the respiration of her crew. It is said to be capable of maintaining a steady course eight meters beneath the surface of the water, for a distance of 500 meters, traveling at a speed of about four knots per hour. It is also said to have remained under water as long as forty minutes at a time. A Spanish boat of similar construction is cigar-shaped, 9½ feet in diameter at the thickest part and 72 feet long, and can make, under water, a speed of six knots per hour. It is reported that a considerable number of sets of plans and specifications for submarine torpedo-boats have been submitted to the United States Navy Department, and are now under consideration. A Chicago inventor is said to have constructed a boat of this character, in which two men have remained submerged, without serious discomfort, for a period of nearly two hours. The use of electricity as a motive power had immensely simplified the problem of producing a practicable submarine boat, and we may reasonably expect some very remarkable developments in this line at no distant day.

PROFESSOR BLAKE, of the University of Kansas, has made an interesting comparison between the light of the sun and the artificial light produced by electricity as exemplified in the illumination of the grounds of the World's Columbian Exposition. According to the experiments of Professor Langley on Mount Whitney, it appears that the energy received by the earth's surface from the sun's vertical rays amounts to 1.6 kilowatts per square meter, of which some 35 per cent. is in the form of light. The area of the exposition grounds is computed at 4,200,000 square meters, and hence to light this space by the sun must require an expenditure of energy equal to 1,466,400,000 watts, or 1,965,000 horse-power. Assuming the statement to be correct that 5,200 arc and 90,000 incandescent lamps are employed to light the grounds, the energy required would be about 14,200 horse-power, from which it appears that nature expends about 140 times as much energy as man in the illumination of the total area covered by the World's Fair.

THE American Institute of Electrical Engineers has established its headquarters in the gallery of the southern end of the Electricity building at the World's Fair, overlooking the grand plaza. Besides a well-stocked electrical library, and files of the professional and other journals provided for the convenience of visitors, a very interesting collection of sketches, models, and relics will be on exhibition; among other things one of the original models of the electric railway, made by Thomas Davenport, the Vermont blacksmith, early in 1837. Extensive preparations are making for the Electrical Congress, which is to meet on August 21.

THE West End street-railway of Boston is making an experiment in the way of a continuous track, formed by electrically welding the joints of the existing rails. The welding plant is mounted upon a box-car, and the power is derived by a connection directly from the trolley wire. The ends of the rails are first cleaned by the application of an emery wheel operated by a small motor, after which the welding clamps are applied and the current turned on. The time occupied in welding each joint is from five to ten minutes. Besides the physical advantages of smoother riding, and less wear and tear of rolling-

stock and track, it is expected that the conducting capacity of the track for the return current will be materially enhanced. Investigations already made show that there is little trouble to be apprehended in respect to the effect of changes of temperature on long lines of continuous rails.

A SECTION of street-railway in which the electric current is supplied to the motor-cars from underground conductors is now in experimental operation on Coney Island, N. Y., which embodies some novel features, and appears to possess many elements of success. The conductors are thoroughly insulated, and are only put into connection with the car at the moment of its passage. The contact devices are placed in a conduit, and are successively brought into operation by a metallic shoe attached to the car. This idea, broadly speaking, is not new, but the manner of its application is certainly novel and ingenious, and its operation appears to be very satisfactory. The inventors of this system have apparently made a long step towards the solution of one of the most difficult problems of the day.

THE substitution of electricity for horses on the street-railway system of Brooklyn has now progressed to such an extent that nearly half of the total number of cars in use in that city are running by electricity. The change in motive power has been accompanied, as it has everywhere else, by an enormous increase in the volume of traffic. Indeed, it is said that the effects of the competition are beginning to be seriously felt by the elevated steam-roads. More powerful engines are being substituted for those formerly in use, and the speed of the trains has been increased as much as practicable. It is probable, however, that the general increase of travel, due to better facilities, will soon make good any temporary loss of patronage which may have been suffered by the elevated lines.

NO electrical device ever invented has attained half so great a popularity as the little rotating fans, which are adapted to be placed on a table or desk, and connected with the electric-light service, and will thereafter give a continuous and refreshing breeze for any length of time at the trivial cost of one cent or so per hour. This is perhaps the cheapest comfort to be had in the market at this time of year, although riding on the front platform of an open electric car on a pleasant summer evening at the rate of half a cent per mile is a close second to it. The rotating electric fan was invented and patented many years ago by a South Carolinian, but, most unfortunately for him, the patent expired before the introduction of cheap electric service rendered the fan a commercially valuable invention. Still it does seem a pity that the inventor of such a beneficent little contrivance should go wholly unrewarded. If every one who uses one of the fans should contribute not more than a dime, he would soon be rolling in wealth.

A GENTLEMAN of Brookline, Mass, has frequently appeared on the streets of that aristocratic suburb, mounted upon an electric carriage of unfamiliar and possibly terrifying aspect; but an irate citizen, whose favorite horse objects to the appearance of the new competitor, has filed a petition with the municipal authorities for its suppression. There was a great deal of fun at the hearing, but the probable upshot will be that the "electrical tortoise," as somebody called it, will be allowed the freedom of the town. The modern horse might as well make up his alleged mind first as last to accustom himself to a great many strange and uncanny sights. It begins to look, by the way, as if he might ultimately become a strange and unfamiliar sight himself.

AN electric railway has been constructed in Japan for the purpose of transporting boats between the ocean and a high-level inland lake.

MECHANICS

Conducted by Leicester Allen.

SINCE the matter for this Department for the July issue was prepared, there have been several events of interest to marine constructors. The first was the exhibition of remarkable speed which the *Campania* is capable of under favorable circumstances. This noble steamer has developed one of those surprises of which she was predicted to be capable by "A Clyde Engineer," in his interesting paper in this Magazine, written before she had made her first voyage, although not appearing until after her arrival in New York harbor. In making her record of 548 miles in a single twenty-four hour run, she exceeded by about 18 miles the record of the *Paris*, which had hitherto been the best day's run ever made by a steamer on a westward trip. On the following day she also made a record of 532 miles. While this may possibly be due partly to her model, nothing but the very best construction and design of her engines and boilers would have enabled her to accomplish this great feat. Another notable event is the successful launching of the United States battle-ship "Massachusetts," from the yards of the Cramps at Philadelphia.

A marine event which is recorded with great regret is the sinking of the English battle-ship *Victoria* through a collision with the *Camperdown*. Besides this very unwelcome evidence of the destructive power of the beak peculiar to our modern war-ships, it has brought to prominent notice the peculiar distinction existing between the respective effects produced by the impact of a very heavy body moving at a low velocity, and of a much lighter body moving at a very high velocity. The latter, while it can penetrate deeply, thus producing a small opening through an obstructing body, does not produce nearly so extensive a rupture as the former. Of course this holds true with reference to the modern system of armor plating, in which resistance to the penetrating power of projectiles moving at very high velocity has been very greatly increased. It may be that ramming by war-ships will prove to be their most formidable means of attack in future marine warfare.

THE shipbuilding industry appears to be languishing on the Clyde, while the very opposite condition is seen in the most prominent shipyard of the United States, that of the Cramp Company at Philadelphia. From English papers it is gathered that prices obtainable for vessels built at the Clyde shipyards have shrunk till there remains little or no profit in the business; and that, notwithstanding the fact that contracts for merchant steamers can now be made at about half the price possible a year ago, there is a serious falling off of orders. *Per contra*, at the Cramp Company's yards in Philadelphia there is the greatest activity. There are 4500 men now employed at these yards, and the company will, it is stated, immediately proceed to greatly enlarge the capacity of their present plant. When the contemplated enlargement has been completed, the company will increase their pay-roll to 6000 men.

NOTWITHSTANDING the great anticipations that were cherished on the part of the projectors of the international congresses to be held in connection with the World's Columbian Exposition, and the cordial approval of the scheme accorded to it by the technical press throughout the world, the interest of the general public in the congresses has, so far, disappointed their promoters. The truth is that those who go to the exposition for the most part do so simply to gratify their sense of the wonderful, the magnificent, and the beautiful, and to see the strange foreign faces,

costumes, and customs that they never expect to have an opportunity to see anywhere else. Beyond the merely superficial knowledge they can acquire through hasty observation by the use of their eyes alone, they do not wish to learn anything; this fact is daily becoming more pronounced. Nor is this to be wondered at, when the nature of the exhibition and the nature of mankind are considered. A vast collection of curious and interesting objects is to be seen, and in ninety-nine out of a hundred cases those who want to see have limited time and limited purses. To attend the congresses they must sacrifice a part of their time for doing what they came to the exhibition principally to do,—namely, to see the show; and they find, when they get there, that the show is so much larger than they had any conception of when they started from home, that to see it, even in the most cursory manner, they must economize time to the utmost. Even those who started out with the resolution to devote a part of their time to attendance upon some one or more of the congresses, when they stand in the presence of the mighty collection that solicits their admiration, will be, many of them, fain to say: "We have no time to attend congresses. This is a so much larger contract than we expected that we must set aside all subordinate purposes." The more important congresses are, however, yet to come; and numerous papers will be read by eminent men on a great variety of subjects. Nearly all of these papers will appear in print, so that, after all, the trouble and expense of holding the congresses will not be lost. The literature of technology will be enriched, and, in the opinion of the writer, by none of the congresses more than the one in which the American Society of Mechanical Engineers will have the opportunity to exhibit to the world the ability of its membership.

INCREASED attention to the health and comfort of workmen in shops and factories is manifest on the part of many leading establishments. A conspicuous example of this has recently been made public, in the provision of improved bathing and washing facilities in the well-known works of J. H. Williams & Co., Brooklyn, N. Y. These works are devoted to the manufacture of drop-forgings, an industry which, like most of the operations in iron working, exposes workmen to the discomforts of heat and the accumulation of black dust on their persons and clothing while at work. The comfort and luxury of facilities for rapid and complete ablution of the entire body at the dinner hour or at the close of the hours of labor for the day can easily be imagined. To provide such facilities the firm named has fitted out a large and commodious wash-room, affording space for a large number of men to wash and bathe at the same time, closets for dressing and for the retention of clothing being also supplied. The bath-tub system has been set aside in favor of shower-bathing, for the reasons that the latter requires much less room, and that thorough cleansing can be more quickly accomplished in the latter method of bathing than in the former. In shower-bathing pure water constantly replaces water that is soiled in washing, and, though it might at first seem that more water would be consumed than would be needed if tubs were used, experience in shops has shown that less water is wasted by having the workmen wash in running water than if they are allowed to draw it into sinks, buckets, or basins. The example set by the enterprising firm named might well be followed by other manufacturing establishments, not only out of consideration for the welfare of the men employed in them, but because those who have observed the effect of personal cleanliness in shops have universally declared it to pay excellent interest upon the outlay required to secure it.

THE method of manufacturing tubes known as the "Mannesmann" process has justly commanded admiration on account of the simplicity of the means employed to produce the desired effect. Before the invention of the process, few would have been found to credit the possibility of the production of a tube by a simple process of rolling. Like the stand-

ing of an egg on the end, the method seems feasible enough when one is shown how it can be done. Now we are told that another method of making tubes has been invented by a German mechanic, Herr Ehrhardt, of Dusseldorf. The tubes are made of steel, and at a single heat. The method, in the first stage, is somewhat analogous to punching. It gives promise of success particularly in the manufacture of seamless tubing of moderate lengths. The method consists in placing a bar of steel of square cross-section in a matrix of sufficient strength having a hole of the exact diameter of the outside of the tube, and then, without giving time for cooling, forcing a mandrel having a rounded end, lengthwise, centrally into the matrix and centrally with respect to the heated bar which is held from moving longitudinally in the matrix. The bar out of which a tube is to be made by this curious process must have square cross-section of the size of a square inscribed in a circle having the diameter of the hole in the matrix that limits the size of the exterior of the tube and gives it its external form. The area of the cross-section of the mandrel would seem, therefore, to be limited to an amount equal to the difference of the areas of the inscribed square and of a circle having a diameter equal to that of the hole in the matrix. A little thought will enable it to be seen that, if this supposition be correct, the thickness of the shell of the tube formed in this first operation must bear a fixed relation to the exterior diameter; and this appears, unless it can be explained away, one of the disabilities of the process, resulting in the limited length of the finished tubes that, as yet, has been found practicable. The process is, however, still in the very infancy of its development, and it is extremely interesting as exhibiting the extent to which the flow of metals can be rendered available in mechanical processes. In this process the metal is forced to assume the form of a hollow cylinder around the mandrel, between the latter and the inner surface of the matrix. It is said that a difficulty which would be likely to suggest itself to mechanics—namely, the tendency of the mandrel to deviate toward one side of the mold—does not materially interfere with the success of the process unless there be some imperfection in the quality of the material worked. It is also said that tubes of 7.88 inch internal diameter have been made by the Ehrhardt process, the pressure required to operate the mandrel for a tube of this size being 180 tons. The end of the heated bar farthest from the mandrel is at first made to abut against a very strong and heavy slide; and when the rounded nose of the mandrel has nearly passed through the bar, this slide is moved transversely so as to bring a hole in line with the advancing mandrel, which, continuing to move, punches its way through; its protruding end is then seized by tongs, and entirely withdrawn. The above operation completes only the first stage in the process. The tubes are finished by drawing and redrawing till a length is obtained corresponding to the size of the original bar and the required thickness of the shell.

ANOTHER new valve-motion invented by Mr. David Joy, known everywhere to steam engineers as the inventor of the valve-motion to which his name has been given, is attracting atttention as possibly having in it the promise of a very wide application to all kinds of engines that require to use reversing gear. In this invention Mr. Joy has reverted to the employment of the single, shifting eccentric that ranks among the earliest devices used for reversing steam engines. This device, when moved, as formerly, by sliding wedges, was found to be mechanically defective, and upon the invention of the link-motion it went entirely out of use. The defects were not inherent in the shifting-eccentric, which effected all the control of the valve sought for; but they pertained solely to the means for shifting the eccentric across the axis of the crank-shaft. Other means than the sliding wedges were devised, but the link-motion (one of the most beautiful mechanical movements ever devised in connection with the steam engine) became so popular that, for a long time, little attention was given to the problem of reversing valve-motions. To Mr. Joy belongs the

credit of devising a valve-motion in which the movement was derived from the connecting rod instead of the crank-shaft, and this has been used in competition with the original link-motion to a greater extent than any other valve-motion that has been invented since the first introduction of the link-motion. This eminent inventor has now provided a means whereby the shifting-eccentric may be operated without any of the disabilities of the old sliding wedge movement. He forms cylinders on the eccentric into which plungers attached radially to the shaft are fitted. Through the shaft is formed a longitudinal passage for oil, the oil being forced through a small steel tube connected both with the passage in the crank-shaft and with a small force-pump on the foot-plate of the engine. Accordingly as the oil is forced into one or the other of the cylinders on the eccentric under the plunger therein, the eccentric is forced across to one side or the other of the axis of the crank-shaft. If the oil be equally forced into both cylinders, the eccentric takes a position corresponding to the mid-gear of the link-motion. The *Engineer* (London), in which has been recently published an illustrated description of this new motion, speaks very enthusiastically of it as being very much cheaper than the ordinary link-motion, more easily manipulated than the link-motion, and fully equal to it in the control of the admission of steam to, and the exhaust from, steam cylinders.

A GOOD deal is said and written nowadays about the moral obligations of employers to feel an interest in the private lives of their employés, and particularly about their obligations to exert a sort of paternal care over the habits, associations, and education of the young men and boys in their establishments. There is no denying that, if this could be carried out in the sense implied by those who advocate such a course, both employers and employed might be benefited; the former, in obtaining a higher standard of honesty and integrity in their service, the latter, by an influence that would tend to elevate them in the social scale, and to protect them from the many besetting temptations to folly and misdoing that assail youths of the period.

There is no doubt that under the now extinct system of apprenticeship which formerly existed, when all sorts of mechanical trades were carried on in small shops, and when those serving their apprenticeship lived in, and were substantially a part of, the families of their masters, there was generally a higher tone of morality among mechanics than there is at present. The masters had an authority over apprentices then which, if they chose to exert it, was scarcely inferior to that of a parent over children. It is to the credit of those "good old times" that, in the majority of cases, this authority was more or less exerted; and that it was considered an element of prosperity in an employing master, in any of the trades, that he had a reputation of being strict with his apprentices, both in the trade instruction he was bound to impart and in the supervision of their associations and habits. Such a reputation, coupled with a reputation for liberality in the treatment of apprentices, as regarded their food and lodging, enabled a master in any trade to enlist in his service the brightest and most desirable youths in his immediate vicinity, and thus supplied his shop with more intelligent and reliable workmen than it would otherwise have been possible for him to have obtained.

BUT the times have changed, and with them have gone such possibilities. Beyond contributing to and aiding in the support of night-schools, libraries, reading rooms, etc.,—all good in their way,—and such very brief supervision as he can give in his occasional surveys of his establishment, which, for the most part, is left in charge of his superintendent and the foremen of departments, it is entirely impossible for a proprietor of a modern manufacturing establishment to exert any strenuous influence upon the private life of those employed in his business. Even his personal example, which may be excellent, fails of effect upon his wage-earners,

because his life is, and must be, almost wholly apart from theirs.

ONE thing, however, might be done by proprietors, which would be beneficial to all youths in their establishments. The superintendent should be selected as a man not only of skill in the conduct of business, but as a good man, and a good citizen; and he should be held responsible for the selection of foremen who not only possess skill in their respective departments, but who are also good men and good citizens; and these should be given to understand that they are not merely engaged for making the young men in their departments serviceable through training of hand, and eye, and mechanical judgment, but, by example, to exert a salutary influence upon their habits,—to advise, and, if need be, to reprove anything coming to their knowledge in the lives of the men under their charge, that tends toward evil practices. It is to be feared that in many manufacturing and commercial establishments even this kind of supervision, the only one that remains practicable under the altered conditions of industry, is either very perfunctorily attended to or altogether neglected.

THE production of the flexible metallic tubing invented by M. E. Levavasseur, would certainly have been impossible with such tools and appliances as were available forty or fifty years ago. It is a notable example of the extension of modern engineering resources. A tube approximating in flexibility a rubber hose, that can withstand an internal pressure of 300 pounds per square inch with safety, and is so substantial in construction that a cart can be driven over it even when there is no internal pressure to assist in preventing the collapse of its walls, is indeed an acquisition. The numberless uses to which such tubes can be applied will suggest themselves to the mechanical reader without any specification of them in this Department. The origin of the invention is interesting. It is the outcome of an idea that has gradually evolved in the mind of the inventor, and which has grown out of the manufacture of a kind of jewelry that was popular between 1870 and 1880, not only in France, but in England and America. People will easily recall to mind the bracelets and necklaces referred to, which had the form and appearance of a tube built up of laminated sections each overlapping another, so that, when the articles were wound about the neck or wrist, they had a strong resemblance to the scaly form of a serpent. Later M. Levavasseur improved the manufacture of this kind of jewelry, each article being made of a single coiled strip in which the convolutions were ingeniously made to interlock each with the adjacent convolutions. This brought to his consideration the possibility of making a water-tight flexible tube of metal having a construction similar to the necklace described, except that the joints were made tight by interposed rubber packing. After patenting the invention in this form, the inventor found that the joints could be made tight without the employment of rubber packing, by a series of ingenious mechanical processes, and the result is a flexible tube that is steam- and water-tight. Doubtless, for some uses, wherein the metal of these tubes is exposed to corrosive action, they would prove objectionable; but there are many fields of usefulness for such tubes. One of these is their employment as conduits for petroleum and other hydrocarbon liquids and gases. In a paper recently read before the Society of Arts, London, by Mr. Gilbert Redgrave, these tubes were described, and it was asserted they had been employed for conveying petroleum under a pressure of 300 pounds with perfect success.

ARCHITECTURE.

Conducted by Barr Ferree.

THE Department of Architecture earnestly hopes that all who read these pages will make a visit to the World's Columbian Exposition. The Exposition is so vast, the matters of interest so numerous, that a conscientious visit is no light task, but it is impossible for one to regret it, and the remembrance of it will be retained as long as life lasts. One should not try to see too much, and it is better to see a small part of the Fair well than to see all of it after the usual American fashion of walking rapidly past a number of articles and remembering anything that may have struck one in the promenade. On this plan, which is an extremely simple one, if nothing strikes there was nothing there. Doubtless many thousands will visit Chicago this year on just this plan, but grotesque as it is there are so many points of interest that it is impossible to escape without some good thought, some fresh inspiration, some new idea. That this will be beneficial to the country at large is apparent from the class of people one meets upon the grounds. Even in the early months, before the excursion business had a ghost of a show, the grounds were filled with country-folk from way back, all intent upon the novel show spread out for their amusement and instruction, and all intent upon seeing as much as possible in a limited time. But alas for human intentions! The mind may be willing, but the body is weak, and one can get weaker in Jackson Park in less time than any other place on earth. Exhibition visiting is work entailing considerable fatigue, and when to this is added the fresh and uncalled-for misery of no seats, or very few of them, what was to be a pleasure becomes a task. Perhaps this is why the people take their pleasures so quietly. There is no holiday-making at the Fair, no public expression of jollification, such as would be part and parcel of an international exhibition in Paris. A visit to the exposition at Chicago seems to be a serious matter,—and so it is, thanks to the management and its policy of charging for everything save air. But Americans take their pleasures quietly, and are not given to making merry with strangers and chance acquaintances; so the subdued aspect of things may, perhaps, be put down as illustrative of a national trait. One word of caution may be added. However it may be late in the season, there are no signs of high prices and exorbitant charges in the early months of the exhibition. The hotel business has been so very much overdone that high rates for rooms are impracticable, and even the restaurant charges on the grounds, where the very highest prices would necessarily obtain, are by no means high. It is true the meals and service are not always of the best, and the lunch-counters err too much on the side of cheapness, but it is not necessary to exhaust one's bank-account, or mortgage one's real estate, to make quite a prolonged stay at the Fair.

THE American architectural drawings at Chicago form a good, fair collection, scarcely better than an average Architectural League exhibition, but representing very justly, on the whole, what American architects think good and proper to send to a public exhibition of this nature. This means, of course, that the "pretty" pictures predominate over the architectural ones, and that it is the popular eye, not the professional judge, which has been most thought of. Of water-color drawings there is an unusual number, some being of buildings, others fancy sketches or picturesque bits of foreign travel, very well done as a whole, but decidedly out of place in an architectural exhibition. Such work as this had better been put in the

water-color rooms of the exposition. If one were justified in generalizing on distinguishing traits of architectural work from the drawings shown at Chicago, it would appear that American architects make freer use of water-color than foreign architects, or certainly much more so than English. But this doubtless comes from the idea of pleasing the general public in exhibitions, or in tickling the fancies of unarchitectural committees in competitions, for, generally speaking, the rendering of a large building, and especially of a large business building, in water-color, is an unnecessary operation. As architecture goes in this country, and considering especially the nature and kind of drawings prepared for public inspection, it is difficult to see how the collection could have been bettered. This does not mean, if you please, that it is the best thing under the sun, or that the collection is something to fill the heart of every architect and architectural student with pride and joy; it is simply as good as we do. Like the manufacturer who boasts that his exhibit at the Fair consists only of stock goods taken from his regular lines, the architects of America may justly claim to have sent only the drawings they had on hand. No one could accuse them of getting up displays especially for the occasion. It is, to put it bluntly, a stock exhibit, arranged and selected with a little more than the usual care. One must protest, however, against the old drawings, the relics of ancient competitions with which the collection is crowded. Why, for example, should Messrs. Carrère and Hastings bring out their drawings for the New York Protestant Episcopal Cathedral? These have been before the American public for a number of years now; they were rejected by the Cathedral trustees, and have scarcely more than an archæological interest at the present time. Further than this, this firm has done more and much better work since that is more worthy of a place in the collection. Quite a number of architects show cathedral competition drawings, Messrs. R. W. Gibson, William Halsey Wood, Parfitt Brothers, and several others being represented.

As is usual in American architectural exhibitions, the drawings are chiefly façades. Few sections and plans are shown, and no hint whatever given of the influence which current methods of construction have upon architectural design. An exception to this is supplied by a young gentleman from Paris who contributes a vast series of large drawings illustrative of what he calls a "country mansion." This is conceived and carried out in the most abominable taste of the French Renaissance, and with the utmost disregard of cost and utility. The drawings take up a great deal of room that might have been much better occupied, and it would be interesting to know why the committee admitted it. But here it is, and it calls for one good word, since the author has been generous in his sections, though his design is bad and his conception worse. The two great strong points of American architecture, the country house and the high building, are illustrated in a variety of ways and in a variety of styles. On the whole the country house is sufficiently well illustrated, as is also the country church. One cannot help asking, however, why Messrs. Peabody and Stearns should have sent their frames of—it is difficult to get the right word to describe them, since though done with water colors they do not warrant the dignity of being called water color—small churches. The artist, if such he may be called, was so eager in his search for the picturesque that his imagination ran away with him, and he has only succeeded in producing sketches that illustrate what ought not to be done. The high building is scarcely as well represented as it should have been. Apparently the canons of taste of the different committees differed so widely, and so much difference of opinion exists as to what constitutes a well-designed high building, that almost anything could get in and did so. Yet some fine drawings of fine buildings are shown, notably a very large water color of the Ames building in Boston, which, notwithstanding its size, scarcely does the structure justice. Mr. Bruce Price exhibits his wonderful study for a thirty-two

story office building, which the New York *Sun*, when it has nothing else to say, is constantly threatening to build. No drawing is more likely to attract the attention of foreign visitors than this; it is a very serious attempt to solve a very difficult problem. It is, however, only an attempt, and should not be considered a finality. Some notion of the incompleteness of the collection may be gathered from the fact that Messrs. Adler and Sullivan are represented only by a single drawing, that of their Union Trust Building at St. Louis, and which, strangely enough, is hung apart from the mass of the drawings.

AFTER inspecting the English drawings, one returns to the American collection with a sense of satisfaction. It is difficult to imagine a less representative collection than that purporting to illustrate the work of the British architects. If the American architects have gone back five or six years to unearth old drawings, the English have gone back twenty or more. In fact, some of the drawings are so ancient that it requires no stretch of the imagination to suppose that they have remained in this country since the Philadelphia Centennial. Mr. R. Phené Spiers, who certainly is not dead, since it is only a short time since he read a long paper on Italian architecture before one of the English architectural societies, sends two drawings done in 1876, both very bad in design and in rendering, and both quite unfit to send from London to Chicago for the purpose of instructing the barbarian Americans in all that is good and true and beautiful in architecture. Quite as blamable is Mr. J. Oldrid Scott, who figures extensively in the catalogue, and whose contributions include, among other things, a huge "New Town Hall for Manchester" and a similar structure for Hamburg, in which latter drawing he was associated with the late Sir G. G. Scott. Neither of these things, fortunately, has been erected, but both are at the very least twenty years old, both are very bad in design and in rendering, and both are things any architect may well feel ashamed to have produced. But apparently their author and the English architectural committee deemed them worthy of sending four thousand miles that foreigners may see them. It is quite impossible to explain the presence of such drawings at Chicago save on the grounds that no one knew they were being sent or else the opportunity and occasion were not appreciated. Had English architects wished to express their utmost contempt for America and things American they could not have done it more clearly and precisely. American architecture in its latest development is not a sealed book to English architects; the work of American architects is quite well known in England, though not so well as it should be. Mr. Scott's horrible Gothic town hall for Manchester is not only a depressing exhibition of what an architect is capable of doing, but its presence at Chicago is a positive insult to American architects. A very large part of the English collection was apparently selected on the grounds that anything would do for America, and accordingly anything was sent. Yet, though there was every reason for making the collection a representative one, it is impossible for any one who has followed the development of English architecture as reflected in the illustrated professional press to accept it as such. English architects can do better than they have shown here; why, then, did they not give some evidence of it?

AND they have. For, bad as many of the English drawings are, there are many others which are not only very good in their way but absolutely so, and go far to redeem the general degradation of the collection. A number of churches are shown that are well worthy of attentive study, and, though few important buildings are exhibited, several, as notably Mr. Ashton Webb's design for the completion of South Kensington Museum, are of the first rank. This drawing, which has been rendered by Mr. Raffles Davison, who stands in the very front of living English architectural draftsmen, merits attentive study as an example of draftsmanship. Such delicate pen drawing as this is not produced in this country; line drawings and water colors being the favorite mediums

with us. But this drawing, and a number of others, likewise in pen and ink, show how very much superior to American draftsmen the English are. Some drawings shown by Mr. T. G. Jackson, notably his "New Front of Brasenose College, in the High Street, Oxford," are especially remarkable in the care lavished upon them. It is true that many of these drawings closely approximate engravings in appearance, and not a few of them require careful examination to show they are not engravings, but they are nevertheless most notable examples of pen-drawing. Beautiful as they are, they must be criticised for their small size. Mr. Davison's drawing of the South Kensington Museum, for example, is on so small a scale that no detail whatever can be shown. Many other drawings are almost microscopic in scale, which, though well suited to the style of rendering employed, is quite improper for representing important architectural construction. In fact, whatever be the mode of rendering adopted, the English architects seem to prefer a much smaller scale than is usual in this country. Many of our own drawings are entirely too small, but the English architects are much worse. Most of the large drawings shown in the English section are very bad indeed, both in subject and in rendering, though whether all these things be connected organically it is impossible to say. For design the English section has little to interest American visitors, but in architectural draftsmanship it has much both of interest and of value, and that notwithstanding the presence of some very bad drawings.

STRANGELY enough, the French make the poorest architectural display, England, France, Germany, and America being the only nations which make any pretence at illustrating architecture to any extent. The entries in the catalogue show seventy-five numbers for France and 144 for Great Britain; the former includes an unusual proportion of decorative sketches, so that the actual number of architectural drawings is very small. This must be a great disappointment to the Frenchites of America, as before the exposition opened they must have anticipated worshipping at the shrine in Jackson Park and calling upon the world to do likewise. As a matter of fact there is nothing in the French section which warrants in the least the marvellous hold French architecture and its system have upon architects in America. Neither is there any special indication that French architects are doing any important public or private work at this time. If one takes out the drawings for foreign structures,—and it may be well to note that no hint is given of their actuality or not,—there is very little French work left; and if from this is removed the restorations and studies of the antique and medieval remains there is almost nothing left to show either what French architecture is doing or can do. In its way, therefore, the French collection of architectural drawings is much more disappointing than the English, since one naturally expects more of it. The most noticeable drawings are the restorations and studies, a kind of work which forms a delightful pastime for French architects, and especially for French architectural students, and which is not known in this country save to those personally familiar with the methods and processes of French architecture. All these drawings are on a very large scale, offering a most delightful contrast to English and American work in this respect, and they are further noticeable in actually illustrating the constructive features. In other words, when a French architect makes a drawing, he produces an architectural illustration. To him, as to every right-minded architect, the plan and sections, as well as elevations, are more important than the production of picturesque drawings. He does not disdain perspectives, but the plan and sections are more essential. And yet with all the following of French ideas in current American architecture this very important feature has been overlooked. This is the chief lesson the French drawings at Chicago teach; no one must look for originality or even design.

THE German drawings are noticeable

for their really immense size and generally uninteresting design. Large as the French drawings are, they are greatly exceeded by many of those in the German section. And these gigantic drawings are very useful to study and are one of the few things American architects may profitably take heed of. The smallest building is a large object to depict on paper, and the building can be so much more readily studied, the detail can be so much better illustrated, the whole effect is so much clearer in a large drawing that it is much to be regretted that current American practise is towards small ones. At all events no greater contrast than the immense drawings of the Germans and the minute pictures of the English architects could be imagined, and the advantages are clearly on the side of the former. Quite a number of these drawings are done in India ink, and others in crayon with a stump pencil, the result being a lithograph-like drawing such as is not shown by any other body of architects. The professional man can find no more profitable occupation at the Fair than making a comparative study of the styles of rendering in vogue in the different countries, all of which are very well illustrated there. But apart from the interest attached to the rendering there is little of value in the German architectural drawings. Like the English and French, the Germans seemed to have thought it desirable to send some drawings made years ago, a number of which have evidently been included. More interesting than the drawings are the plaster models of German buildings, likewise shown in the Fine Arts Palace, where they make an imposing show from their large size. The most important of these is a model of the German Houses of Parliament at Berlin, executed on quite a large scale, which shows the detail very fairly. The building is a familiar one to American architects, and therefore it need not be described here. French in conception, it is carried out with a German feeling of uncertainty and unfamiliarity with the style that robs it of natural expression. Two models of Romanesque churches, one a memorial to the first emperor, the other the Gnadenkirche in Berlin, are also shown. Both are new buildings designed in the German historic Romanesque, which may very properly be called the German national style. They thus gain a special interest as pointing, perhaps, to a revival of a former style, in which German architects once worked with freedom and ability, and which was susceptible of a higher development than it received.

IT is earnestly to be hoped that architects and engineers in visiting the Fair will avail themselves of the opportunity to study the real merits of Chicago architecture, as illustrated in the best of the high buildings of that city. More than once, in these pages, we have pointed out how much more thoroughly the Chicago architects as a class appreciate the structural limitations of design in high buildings than their brother architects in the East. Not all of Chicago's high buildings are good,—many of them are very bad,—but on the whole the expression of the conditions underlying the high building are better shown in Chicago than in any other city. But one must put away one's prejudices before he can properly appreciate what the city has to show in commercial architecture. One must be prepared to see buildings sixteen stories high with no horizontal lines save those of the basement and the frieze, to see bays one and two windows wide and ten stories high without a break and without the additions and so-called ornament that make up the larger part of high-building architecture in the East. No building is better worthy of study, in this respect, than the Monadnock, which not a few, perhaps, would class as engineering alone, without any architecture whatever, so plain and solid are its walls, utterly unrelieved by anything save the windows. It is interesting to compare the older part of the building, in which this system of designing is best illustrated, with the new part now rapidly nearing completion. The addition, which covers as much ground as the original structure, is by different architects, who, however, approximate the style of the older part while making it somewhat more ornate.

Quite as interesting, and quite as impressive, also, as a study in designs, is the Old Colony Building, by the same architects, Messrs. Holabird and Roche, and which, likewise, is rapidly nearing completion. Here is nothing but the architecture, or rather the walls and windows, to attract attention, yet it shows what can be accomplished by the use of the simplest elements in the simplest manner. Chicago has no more impressive business building than this, and the system on which it has been designed warrants attentive study.

ARCHITECTS in general, and Messrs. Adler and Sullivan, of Chicago, in particular, must be amazed at the competitive design for the Buffalo Real Estate Exchange submitted by Messrs. Roberts and White, which was recently published in *Architecture and Building*. No design was ever more openly and deliberately copied from another than was this from the design prepared for the Union Trust Building at St. Louis by the Chicago architects. The copy is so direct and complete as not to be a compliment to Mr. Sullivan. It is not creditable to the Buffalo architects that they should have allowed their appreciation for a good thing to get the better of their judgment and permit them to make a servile copy of a contemporary's work. It is bad enough to appropriate the designs of previous ages, but altogether intolerable to take that of a living fellow-man, though in morals there is, we presume, no difference.

Mr. Sullivan's design for the St. Louis building is an extremely striking and effective one. The main façade shows an external court flanked by two masses, whose chief feature is, in each, three bays carrying round arches and running through ten stories. The basement consists of two stories, of which the second is filled with large circular windows. This is the ornamental story of the building, the motif of the decoration being a lion standing upright and holding a shield between his paws. The building is finished with two stories above the arcades, in which the windows are separated by columns, and with a strongly-marked curved cornice ornamented with the rich and delicate carving Mr. Sullivan has so thoroughly stamped with his own individuality.

In Messrs. Roberts and White's design —which, it happened, was not successful in the competition—the basement consists of three stories, of which the second is very high and plainly finished, while Mr. Sullivan's circular windows, carving, lions, shields, all appear in the third. Above, the building is divided by an external court into two bays, treated with arcades six stories high, as against the ten used by Mr. Sullivan. The building is completed with a two-story duplication of Mr. Sullivan's two stories, followed, as might be expected from what precedes, by the same cornice, similarly decorated. In both buildings the entrance is through a large archway placed between the two wings of the building, though Messrs. Roberts and White, it is proper to say, have introduced a treatment of their own.

All this transference of another man's work to another building and another locality may be intended as a compliment to the originator of the design, but such servile copying is to be most severely reprehended. It is one thing to develop an idea imperfectly understood or incompletely worked out by another, but it is quite different to take all a man has done and give him nothing in return. There is gradually developing, in American architecture, a tendency to appropriate the designs of other people, and the instance we have cited is only going one step further than any one else has yet gone. But the taking of this step should be a warning to every right-minded person that we are drawing very near to the verge of deliberate dishonesty. It is time we drew back from the precipice; perhaps this example will help to point a lesson that there never should have been occasion to learn.

INDUSTRIAL CHEMISTRY

Conducted by Dr. R. A. Witthaus.

DR. FRANCIS WYATT, in his contribution on the "Progress of Chemical Industry" to the statistical volume recently published by the *Engineering and Mining Journal*, makes these following interesting statements:

In a series of essays published in the *Engineering and Mining Journal* in the year 1887, I made an effort to show that, of all the arts which we had cultivated and improved, the manufacture of chemicals had made the least progress and received the least attention. This did not apply to our production of sulfuric acid, for which we were at that time consuming about 90,000 tons of imported brimstone and 100,000 tons of native and imported pyrites, and in which we were able to compare favorably, if not in cost, at least in practice, with that of the best in Europe. The unfortunate circumstance that the great bulk of our acid was made from high-priced brimstone constrained us, however, to confine its use to the refining of petroleum or the manufacture of fertilizers, and none of it went into the production of alkali and soda salts. Our small output of these was derived either from the "ammonia" process or from the decomposition of cryolite; and as we were making no chlorin, or bleaching powder, the mass of our dyers, paper-makers, and glass- and soap-manufacturers were practically dependent upon our imports for the most essential elements in their raw materials. More than five years have elapsed since those essays were written, and although our general onward march in industry has been a rapid and triumphant one, so little change has taken place in this important branch that the picture then drawn might also be used to represent it now. Our manufacture of sulfuric acid has certainly increased, and we have kept abreast of the times by adopting many new appliances for the avoidance of waste and the lessening of cost. We have also, thanks to the energetic advocacy of Adams and other earnest workers, made substantial advance in the direction of pyrites consumption, and have thus placed ourselves on a more equal footing with European competitors. Beyond this we have done little worth recording, and have no reason for self-gratulation or complacency. The American chemical trade has grown to be the prop and mainstay of the United Alkali Company of Great Britain! The American chemical industry is of proportions so insignificant as to be almost a negligible factor, and gives us no voice in fixing the market values for either alkali, soda salts, bleaching compounds, or dyes and coloring matters.

This is a sad commentary on American enterprise, but every one who is in touch with these branches of chemical industry knows this to be the true situation. Dr. Wyatt has recently spent considerable time in Europe, and the opportunities of this visit give added force to his words. But a brighter era is approaching. The LeBlanc process is still struggling for existence and the ammonia-soda method striving for supremacy; but the discoveries of Mond and Gossage in supplying a cheaper method for recovering the waste chlorin promise important advances toward lessening the cost of production and improving the product. Both of these modifications, the Gossage to the LeBlanc and the Mond to the Solvay process, have passed beyond the experimental stage and are reported to have withstood severe tests on the industrial scale. Chemical ingenuity and unlimited capital have combined to solve the problem of cheaper heavy chemicals in Europe, and it will be interesting to observe the effect of all this experimentation upon these industries in America. We are in a position to produce the raw materials used in our soap, glass, paper, and bleaching industries cheaper than they can be made anywhere else in the world, and coal, limestone, and salt are almost as cheap in America as in England. With the raw materials, the capital, and the market there remains only the economic process to transplant the greatest of chemical industries from England to America.

DR. WYATT estimates that the cost of producing sulfate of soda or salt cake in England is $7.30 per ton of 2240 pounds, and bleaching powder, packed ready for shipment, $15 per ton of 2240 pounds. Before this can be made available in the United States there must be added for freight, insurance, and import duty, about 35 per cent. of these costs. The cost of production in the United States is shown to be: Sulfate of soda or salt cake, $7.70 per ton of 2240 pounds; bleaching powder, $16.76 per ton of 2240 pounds. Surely these figures are favorable to the home production. The production of soda ash in the United States by the ammonia process has increased steadily from 10,000 tons in 1884 to 50,000 tons in 1888 and 82,000 tons in 1892.

The per-capita consumption of salt in the United States is about one bushel of 56 pounds, and already the salt industry is paralyzed by over-production. The old process of solar evaporation has given way to more rapid methods by steam and blast, and the system of working the brine is being replaced in some sections by the sinking of shafts and mining the salt in bulk. The market price of dairy salt has fallen to 49 cents per barrel, of which the barrel costs 23 cents. There is no profit in salt at such figures. The natural outlet is not in cheapening the cost of production by substituting mining for boring, but in utilizing the salt in the manufacture of alkali and bleach. Mond's modification of the ammonia soda process, the application of electricity to obtain a greater proportion of chlorin, or such an improvement in the LeBlanc process as that proposed by Gossage, promise to open the way for American manufacturers to successfully compete with the United Alkali Company. Indeed, the recent words of Professor George Lunge, who, more than any one else, is in a position to know, would seem to be prophetic when he says, "We poor Europeans may well tremble as we think of the enormous advantages for all applications of electricity enjoyed by the United States with their unbounded water-power, coal-fields, and oil-wells, not to speak of natural gas. In all human probability they will soon cease to be importers, and may even become exporters of bleaching powder."

PROFESSOR HERBERT E. SMITH, chemist to the Connecticut State Board of Health, has recently completed an examination of Connecticut river in its relation to the public water supply of Hartford, and his report is published in the fifteenth annual report of the Board. The water supply of Hartford is taken from storage reservoirs by the gravity system, but pumps are maintained at the river to be used as a source of supply in an emergency. No such emergency occurred between December, 1884, and October, 1891, a period of about seven years. The Connecticut river was used as a source of supply from October 3 to December 8, and from December 22 to the 30th, 1891. Immediately following this change of water-supply there appeared, in the returns made to the Board of Health, a notable increase in the number of cases of typhoid fever, and this unusually high rate of death by typhoid continued during the months of December, 1891, and January, 1892. This is an unusual period of the year for an increase in the death rate by typhoid, and yet the number exceeded that customary during the summer months. This coincidence led to the investigation, and Dr. Smith's conclusions are stated in the closing paragraph of his report as follows: "From the evidence presented, it has been concluded that the recent use of the Connecticut-river water in Hartford has been the cause of typhoid fever in that city, and that there is little reason to believe that the germs came from the sewers of Hartford, but from some point above. The water in the river just above Hartford must be as pure as at any point in this State, consequently it is unsafe to use for drinking at any point in Connecticut."

ARRANGEMENTS have recently been completed by which a new impetus will be given to the manufacture of aluminum,—metal and alloys. The Pittsburg Reduction Company has entered into a contract with the Cataract Construction Company for 6500 electrical horse power and has

nearly completed plans for a building near the Niagara Falls Tunnel. It is stated by Dr. Alfred E. Hunt, president of the company, that the Cowles Aluminum Company, now using water-power of Eighteen-mile creek, near Lockport, will be removed to Niagara, and occupy a portion of the plant being constructed for the Pittsburg Reduction Company. This is the largest amount of power thus far contracted for by the Cataract Construction Company and is sufficient to produce aluminum in large quantities. Bauxite, from Alabama, will be used as the ore.

DR. RICHARD P. ROTHWELL, in closing his editorial comment on the statistics, technology, and trade of the mineral industry, writes: "There has been no increase in 1892 in the total value of the mineral products of the United States as estimated in these tables, nevertheless the production of most of the minerals and metals has increased in quantity materially. It is natural that, with increasing facilities and competition in producing, both costs and market values should decline, and in most cases profits have also been less than formerly. The disadvantages this vast country labors under in having to transport its raw material and manufactured goods enormous distances to market, with consequent high cost for carriage, are being overcome in part by the creation of markets nearer the sources of supply; in part by the reduction in freights due to competition among railroads and the possibility of reducing charges by reason of increasing quantities carried; and in part by the great reductions in cost of producing which cheaper supplies, larger output, and greater experience, skill, and knowledge of the business have rendered possible. When coal is carried by rail at one quarter of a cent per ton-mile, and many other articles pay less than half a cent per ton-mile, distance becomes a less important element in the development of an industry. That coal is delivered on board vessels 400 miles from the mines at $2 and $2.25 per ton, and both mines and roads make satisfactory dividends; that it is mined at a fair profit, though sold on the railroad at the mines for, say, 65 cents a ton; that hard, free-milling gold ores are mined and milled at $1.25 a ton and 95 per cent. of the gold is extracted from sulfid ores at a treatment cost of $2.50 a ton; that copper ores are mined, milled, concentrated, smelted, and refined at $1.50 a ton, and 62 per cent. high-grade Bessemer iron ore can be delivered a thousand miles from the mines at, say, $3.50,—that such instances of cost of production are possible with average wages at from $2 to $3.50 per day, and that the cost of transportation added still permits these selling prices, are mentioned as examples of the best present practice, and not as examples of average costs. The average commercial cost of producing any article is the average minimum cost at which so much of it can be produced as the market demands. The more expensive producers are the first obliged to stop; the most economical, the fittest, survive, and regulate the market. The enormous progress in the mineral industry of the United States which is shown in these eloquent statistics has been due chiefly to increasing knowledge and experience in the arts involved. The great reduction in costs of production has in most cases been accompanied by a decided betterment in the condition of the wage-earning classes, if not by an absolute increase in the rates of daily wages. Skill and knowledge count far more than the rates of wages in the successful prosecution of an industry. Nor is the importance of knowledge by any means confined to the 'captains of industry' or those who create or develop it, but it is quite as important in the workmen. The introduction of greater skill and knowledge which result in improving the quality of the work and increasing the output per man per day is the most effective and satisfactory manner of bringing about a reduction in cost to the producer; while no advance in wages ever asked for or received could so greatly benefit the wage-earners as would greater knowledge of *their* business by the wives and daughters of workers. A better knowledge of what and how to cook, of how to keep house, and of the common rules and means of promoting health would

be of incalculable benefit to the wage-earners, bettering their condition in many ways, and it would at the same time indirectly tend to promote economy and success throughout the entire industry. The unbounded natural resources and the intelligence and marvelous energy of our people have brought the development of many departments of the mineral industry to the point where, exceeding the home consumption, we must open the wider markets of the world, and make of this country a workshop for supplying other and less fortunate nations."

IN regard to the management and development of the Florida fields, Mr. C. C. Hoyer Millar contributes an admirable paper to the *Manufacturer's Record*. It is Mr. Millar's opinion that Florida will retain the pre-eminent position as a producer of high grade phosphate. "Although in the past the financial results have been unsatisfactory in most instances," he says, "yet this forms no ground whatever for supposing that the hard-rock industry is not a sound one in itself and likely to prove lucrative at all events to those companies which are directed with good business judgment combined with solid practical management." The rash sales of the Florida companies in Europe have forced the mines of the Somme department of France, whose annual shipments have exceeded 100,000 tons, out of the foreign market, confining them chiefly to the home market and the Rhine. The excessive supply was not, however, the principal cause of the low prices prevailing last year; the market is good and steadily increasing. The stagnation is rather to be preferred to the extraordinary and unbusinesslike methods of marketing the Florida phosphates in Europe, and the absence of paying dividends for the same cause. Phosphate was offered at figures below the cost of mining, and large sales were made before the mines were touched or the mining machinery ordered. Such a course as this must naturally result in disaster, and the prosperity of the companies adopting such foolish methods will be materially decreased. Nor has the low market price been of benefit to the manufacturers abroad; they too have been obliged to cut prices, and a strong competition has resulted between those who bought at the lowest figures and those who did not.

Basic slag has come into the market since 1887, but the production of phosphate has increased from 500,000 tons in 1880 to 1,303,000 tons in 1890 and 700,000 tons of basic slag. Mr. Millar strongly advocates a combination among phosphate producers as the best solution of the question as it now stands, and not only among the Florida miners themselves but also at least a definite understanding between them and the South Carolina producers. The latter, while they have a slightly greater expenditure in placing their phosphate f. o. b., can put it in the European market at a somewhat lower freight than their Florida brethren. In urging the combine Mr. Millar takes the stand that "buyers would rather pay a higher price if they felt secure against a drop in prices than buy at a lower figure and be haunted by the possibility of a further fall."

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

A RECENT Supreme-Court decision in a mining suit involving the transfer of a very large sum of money is of considerable interest, especially because the case has been before the lower courts for years, and has at various times had a favorable leaning toward one litigant, soon to be turned in the other direction, so that those who have followed its variegated career have been looking with much curiosity to the final outcome. It illustrates a train of circumstances often likely to occur in the history of partnerships in mining property. In brief, the facts on which judgment was finally rendered were somewhat as follows: Two men jointly owned a mine. One was the active, resident partner or manager; the other was absent, a silent partner, and dependent on his colleague at the mine for information as to its character, value, and changes in outlooks as developments progressed. It appears that the absentee did not get all the information that the court thought he should have had. An important discovery of ore was made. Before this, the absent partner had offered to sell his interest to the managing partner for a stated consideration, in the belief that the property was not valuable and that there were no promising indications of paying ore. The managing partner, it seems, had previously stated in a letter to his brother that the indications *were* very promising, and shortly afterward a local paper reported the finding of a small amount of ore, with the expectation that it would lead to more. Later this paper announced that the expectation had been realized. After this a contract was signed by the managing partner reciting that "a lode or vein is now believed by all to have been struck," but he cautioned his family by letter not to inform the absentee of the discovery. The sale was made. Then the seller, the absentee partner, went into court to have it set aside, and this is what, under different legal complications, the fight has really been about ever since, though the issue has appeared in a suit for either recovery of interest with share in the profits or damages. The ruling declares: "It was the duty of the managing partner to disclose the true condition of the mine; and a sale on the terms offered by the absent partner, who continued ignorant of the discovery, could be rescinded by him in a bill in equity." As thus succinctly and baldly stated, the facts and their judicial conclusion seem clear enough. In detail, they were complicated and the evidence somewhat contradictory, so that the hesitation of the lower courts was natural enough. It should be noticed, as a delicate point in the case, that it was not the knowing manager who proposed the transaction, but his ignorant partner who voluntarily went into it. In fact, there was a plexus of nice points to be adjudicated not stated in this necessarily crude summary. But the main issue is clear—that in mining transactions concealment of information is equvalent to deception. It is a good precedent.

AMONG the exasperatingly wishy-washy, pseudo-plausible, quasi-axiomatic paragraphs floating in the all-receptive current of "patent-outside" journalism may be found the following, taken from a paper published in the mining regions:

> It is never economy for a manager, proprietor, or foreman to put his own labor in the mechanical department, or do such work as could be as fully well done by hired help at small cost.

On its face how sensible it seems, but how like a truism, how like one of Ben Franklin's pithy sayings! And what a convenient cloak with which to cover one's laziness, false pride, or ignorance of mechanical and technical details! But it won't do in the mines. There are plenty of situations where it would be not only a

waste of time and effort, but decidedly bad policy, for a manager to take hold with his hands. To meddle with subordinates' duties unnecessarily and often would be mere fussiness and would ruin discipline, besides wasting time that could be more profitably employed. But to say that it is *never* economy for a superintendent or foreman to do manual work is absurd, a mere theoretical assertion of some one not a man of affairs. He often *has* to. It is his business to understand the details of whatever work he is superintending, and if possible understand them better and also carry them better than his subordinates if need should arise. If he has the skill and dexterity to *do* the work better than they, and can on a pinch take off his coat and show them how, why the men will respect him for it and will learn from him. They despise a fussy man, but like a useful one.

In managing a mine or a metallurgical plant, especially where things are on the small scale and the superintendent is alone with one foreman, not being able to afford a trained technical staff (who, by the way, would come under the same category with them) to look after details, emergencies constantly arise where, in the absence of skilled and specialized labor, he may be the only competent man about. Suppose a new piece of machinery is to be set up or an extraordinary repair to be made, is the manager or foreman to sit under a big umbrella at a distance like an old-time mandarin engineer and send messengers to the men with suggestions or (if they need animating) with threats of disemboweling? Or like an Egyptian slave-driving foreman (as depicted) ride about in a palanquin and be fanned while pointing out with the lash what is to be done? Very likely both these personages understood their business,—that is, considering their time, place, and social conditions; but they went the wrong way about it, judging from the standpoint of our time and conditions. That an accomplished professional man should break his nails and bark his knuckles laying fire-brick arches seems a queer proceeding and misdirected energy at first hearing; but if it is explained that there was no one at hand who knew how or could do it right if merely told how, it seems not only creditable but decidedly practical. Why, in many European technical schools they teach just this sort of thing; used to teach hand-puddling in the iron metallurgy course, in fact; and teach these manual operations to men designed to begin active work as officers. On the other side, fancy a $10-a-day boss-machinist in a large hoisting works walking about with a silk hat and gloves simply explaining and dictating, or an underground foreman too proud to help set a power-drill.

A man who has passed through the several stages of a technical occupation, if he has intelligence and ambition, has found that brains count more than muscle; that he can render more efficient work and earn better pay, generally speaking, in the former than in the latter line. But that will not exempt him from manual work when it is expedient or necessary. Then is the time when brains directing and combined with muscle in the same person are needed. When the emergency is over, he can wash his hands and put on his coat again. It is a failing of too many, when they have risen to a little authority, that they can't see this,—a failing corresponding to that of the clerk who thinks himself above the mechanic.

READERS of the article on Leadville which appears in this number of THE ENGINEERING MAGAZINE will be struck with the wonderful persistence of this famous silver-lead mining camp, notwithstanding a rate of exploration and exploitation unparalleled in any of the older or the foreign mining districts. The individual mines suffer vicissitudes and finally become exhausted one by one; then, or rather while this process is going on, new areas are being steadily found and opened and new mines enter into the list of producers, so that the district as a whole has maintained a remarkable uniformity and steadiness of output, notwithstanding temporary and individual set-backs or strokes of good fortune. In this respect it has resembled a community of men, who are born, run their course,

and fall from the ranks, but whose places are constantly being filled,—a condition resulting from the wide area of ore-bearing ground and from the very large number of individual mining ventures. Since the date when Mr. Wuensch wrote the article in question, the flurry in silver quotations has of course had a most depressing effect. Yet, in spite of this, as in spite of all former troubles, we may look to see this old reliable district in activity for many long years to come.

THERE is reason to believe that the problem of utilizing the immense banks of anthracite culm in Pennsylvania—and, indeed, all coals too fine for use in ordinary boiler-furnaces—is on the point of being successfully solved. This will probably not be done by any expensive system of briquette-making, which has had long trial and great ingenuity expended upon it, without thus far any very promising results commercially; but by the use of modified grates, furnaces, and boilers. Mr. Eckley B. Coxe, who is high authority on the subject, after long experiment, has brought out improvements in furnace construction. Another inventor is reported, who was not at all interested in saving the culm, but who has proposed to actually crush lump coal to a fine powder, and use it somewhat in the same way that petroleum is burned by the atomizing process. The idea is theoretically sound. Success in carrying it into practical effect is dependent on overcoming mechanical difficulties. It certainly seems reasonable to think that coal in fine comminution ought to give a very perfect combustion because so thoroughly acted upon by the oxidizing draft, and consequently abate the smoke nuisance if the blowing out of the particles in short stacks can be prevented, as it is claimed can be effectually done.

IT is announced that several new plants to use the iron-matte or pyritic smelting method for gold and silver are projected to be built in the west. The smelters now using the process have been very successful in treating low-grade pyritic ores, and the cost is reported at not over $2.50 a ton. One principal economy is in utilizing the sulphur as a large part of the fuel. Another is now proposed by introducing hot blast, the blast to be heated by waste heat from the slag.

IDAHO miners have peculiar ideas as to the reasonableness of grounds for going on strike. Last year the union men struck for the payment of the same wages for common labor as were paid to skilled miners underground. Lately, and at a time when a large proportion of the silver mines had closed, or were about to close down on account of low prices for the product, they went on strike again, notwithstanding there were already so many men idle. There is evidently an opening for the professional workman and walking delegate among the Idaho miners, to inculcate a little common sense in selecting time and cause for a strike.

SPEAKING of the experiments being conducted by the Tennessee Coal, Iron and Railroad Co., at one of its furnaces, the *Engineering and Mining Journal* calls attention to the importance which they have to many of the Southern iron-men, and says that, should they prove successful, as they now promise to do, they will open a wide field to the furnace-owners who have relied on their pig-iron alone, and will now be able to produce an iron that will be adapted to the production of steel on a large scale. The *Journal* thinks that, if the Southern iron industry is to continue to prosper, the manufacture of finished iron and steel should be added to that of the raw product of pig-iron.

WHEN silver bullion touched 62 cents an ounce in the New York market in the flurry of June 29, it reached a figure less than half the standard American coinage rate of $1.2929 per ounce, and naturally caused consternation among the silver miners. A number of important mines, among them some that were in the best position to produce silver at low cost, were shut down, throwing thousands more men out of employment. As the smelters

ceased or reduced purchase of ore, it was not policy to add to stocks of ores at the mines.

AMONG the many mineral resources of Colorado are its clays, which are found in great variety. Fire, tile, brick, and terra-cotta clays are largely utilized, but some of the finer clays have not yet received the attention they merit. The *Mining Industry* (Denver) reports an analysis of a sample of Colorado porcelain clay corresponding to standard China clay, and adds: "For years the *Industry* has believed that the clays of Colorado would eventually prove to be a source of great wealth, and that some time the manufacture of fine porcelain would prove to be a great industry." It may be further remarked that in new countries it takes a long time to discover, appreciate, and make use of all the different mineral resources. Those which first attract attention and are most eagerly sought for do not always turn out to be the most important in the long run.

IN the Oregon exhibit in the Mines building at the World's Columbian Exposition is a miniature hydraulic placer-mining plant, which is thus described by a visitor: "The placer mine consists of a bed of gravel fifteen feet long and six feet wide, with a sluiceway through the center. A small hydraulic ram throws a vigorous stream of water against the gravel bank, carrying the dirt down in the sluice where the gold is caught by the riffles, placed crosswise in the box. A number of Oregon placer-mining properties gave the gravel, 100 sacks of 150 pounds each. A clean-up is made after each sackfull is worked."

THE contention of the striking coal miners in Kansas, who went out because the rule of paying on total coal had been changed to that of paying only on coal passing over a screen of a certain size, is that 43½ per cent. of the coal mined in Kansas has not and would not be paid for; that they could only make 56½ per cent. lump coal, on which the schedule is based. The Kansas coals are generally very tender.

THE Tombstone (Arizona) *Prospector* has interviewed a mining expert who had returned from the Altar dry placer district in Sonora, Mexico. He gives the *Prospector* some remarkable information about that camp, which he says is very rich. There is but one company operating there at present, a New York syndicate. They have sixty dry washers operated by 120 Indians whom they pay 75 cents a day. Their returns average $1800 a week. The diggings are 60 by 80 miles in extent and as dry, hot, and barren as the Colorado desert. The nearest water is twenty miles distant and is packed on burros for domestic use. The gold is very coarse. Several pieces which he was allowed to take from a washer are worth from $5 to $20 each. He states that many chunks are found, mixed with quartz, that are as large as hen's eggs. He saw one piece which weighed ninety-six ounces after the quartz was cleaned from it, which was purchased for a trifle from an Indian. One man cleans up the machines every night. He is the only American in the place. The gold is all sold to the merchants around the camp, who take their chances in getting it out of the country without losing their lives.

THE commission appointed by the State of Pennsylvania to investigate the waste in anthracite mining has submitted its report, which is a very exhaustive and practical one, as might have been anticipated from the high professional standing of the gentlemen composing the commission. Attention is directed to the great importance of the amount of fuel that has gone into the culm, bony-coal, slate, and dirt banks, though now a smaller proportion of coal is thus thrown away, owing to the marketing of finer sizes. Better washing appliances and closer classification in dumping have had their effect. An attempt has been made to ascertain the probable average of the coal lost in mining and preparation, which is a difficult matter to establish, owing to the great difference in conditions in different mines and districts. The conclusion reached is that since mining began the coal won does

not exceed 35 per cent., and possibly is not more than 30 per cent. of the coal originally contained in the spaces mined over; and that this may be raised to about 40 per cent. by second mining and recovery from the culm-banks. The total yield, including coal sold locally and used at the mines, has exceeded the shipments about 10 per cent. Assuming that for every ton produced 1½ tons have been lost, and taking shipments at 820,362,925 long tons and total production at 902,000,000 tons, together with an estimate of 19,500,000,000 tons original contents, it appears that 17,245,000,000 tons of marketable anthracite remain in the ground. For reasons cited in the report it is doubted whether the total yield won by the time the fields are abandoned will exceed 40 per cent. This means that about 6,898,000,000 tons more may possibly be expected to come out. This would give a new basis for estimating the number of years it will take to exhaust the three Pennsylvania anthracite fields (a much discussed question), if only some one would offer a reliable prediction of what the annual output is to be in the future. The report abounds in practical suggestions, and should be studied by every anthracite colliery manager.

A NEW form of trap for saving amalgam and mineral has been put in at the Hawkeye gold-mill at Deadwood, South Dakota. It is an inverted cone into which the tailings pass. Near the top are openings to allow water and light pulp to escape, the heavier sinking to the bottom, and thence drawn off through pipes. The principle is one that has long been adopted in one type of concentrators, but the details of construction are described as original.

NEWS of another find of diamonds comes from South Africa. They occur in a conglomerate at Clerksdorp. The discovery was made in cleaning up the batteries of the mill of the Gold Estate mining company, and they were then traced to their source. The stones are said to be of good size and shape, but green. Fifteen tons of the conglomerate tested for diamonds showed that owing to the hardness of the matrix it would be difficult to recover the diamonds without injury in the treatment.

IN April the product of the Johannesburg, South Africa, mines was 112,053 troy ounces gold, valued at $16.80 an ounce, or $2,100,800. Of this amount 18,707 ounces were extracted from tailings by the cyanide process, which is supplanting chlorination there. Nineteen of the mills in the district now use this process, with only one practicing chlorination.

A VERY strange story, but one not altogether without precedent, comes from Cripple Creek district, Colorado. It is said that a lot of gold ore milled there yielded something like $20 a ton more than the assay from a "careful sample—a sample as nearly accurate as could be obtained of the ore tested." Of course this is sheer nonsense. The ores of that district usually give a low percentage extraction of their known contents. The explanation may not be found in attributing any special ignorance or carelessness on the part of the sampler or assayer—though that is quite possible too. Gold ores are especially difficult to sample when part of the gold is coarse. After getting a rough sample down to four pounds or one pound, supposing that to be done accurately (which is a hard thing to be sure of), then the assayer, in taking his final crucible sample, must exercise special care, grinding down the whole to a very fine mesh and making sure that no gold wires or flakes stick in the screen.

GERMANY'S mineral output in 1892 was valued at $187,283,129, and that of the metals (partly included in the foregoing at $104,663,703, in American money. The minerals we presume to have been all of domestic production; but Germany receives large quantities of metalliferous ores from other countries for reduction in her metallurgical plants.

CURRENCY CLEARING-HOUSE CERTIFICATE.

[Suggested by Mr. EDWARD ATKINSON'S paper; see page 555.]

THERE are several forms in which Clearing-House Certificates could be issued. The details of such a measure would, of course, be put in legal form by counsel learned in the law. These examples are submitted merely as suggestions.

CLEARING-HOUSE CERTIFICATE.

Clearing-House of _____

consisting of _____ Banks. Aggregate Capital $ _____

This is to certify that the Bank of _____ has deposited with the Clearing-House Committee of this Association securities of the present value of _____ Dollars, upon which this series of certificates has been issued for circulation by said Bank; such securities subject to be changed from time to time, and also subject to an agreement by said _____ Bank to maintain the value of the securities deposited in said Clearing-House at a sum at least 20 per cent. in excess of the amount of certificates issued thereon. In default of redemption of the obligations of said Bank secured under these certificates on demand in lawful money by said _____ Bank, this certificate will be redeemed in lawful money on presentation at said Clearing-House.

_____

Register.

On the back of such certificate the bank of issue might have the customary form of a bank-note printed, if the tax on bank-notes is removed. Otherwise the obligation might be in the form of a check, which is not taxable as bank-notes are.

_____ BANK,

Pay to the order of _____

_____ Dollars.

_____

Trustee.

To the Cashier:

Payment of this check is secured by a deposit of securities with the Clearing-House Association of _____ under the terms of the certificate on the back hereof.